Model 511

Service Manual

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Part Number 6116-90-00

Novametrix Medical Systems Inc.
Wallingford, Connecticut, U.S.A. 06492.
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R Revision History

18-Jul-94 Release Version 00

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1 Introduction

Purpose 1.1

This manual has been prepared for technicians servicing the Novametrix Model 511 Pulse Oximeter. It presents technical information relating to the monitor's theory of operation, maintenance, calibration and repair. Refer to the Pulse Oximeter Model 511 User's Manual (Catalog Number 6116-23) for additional information.

Technology Description 1.2

The Model 511 measures oxygen saturation and pulse rate with sensors that contain red and infrared light sources, called LEDs. Since oxygen saturated blood absorbs different amounts of light at each wavelength (red and infrared) as compared to unsaturated blood, the amount of light absorbed by the blood in each pulse can be used to calculate oxygen saturation.

The light energy from red (660 nm) and infrared (940 nm) LEDs is beamed through a sample cell—a pulsating vascular bed, the patient's finger or toe for example. The remaining light energy not absorbed by the sample cell reaches a light receptor, called a photodiode, on the opposing side of the sensor. The data received at the photodiode is sent back to the monitor where it is split into its red and infrared components, digitized, processed by a microprocessor chip, and finally displayed as a numerical value for oxygen saturation and a plethysmogram.

The Model 511 is calibrated to display "functional" saturation. This differs from the "fractional" saturation value displayed by most co-oximeters. Functional saturation represents the amount of oxyhemoglobin as a percentage of the hemoglobin that can be oxygenated. Dysfunctional hemoglobins (COHb and METHb) are not included in the measurement of functional saturation.

Calculating Functional Oxygen Saturation

$$\text{Functional Saturation} = \frac{HbO_2}{100 - (COHb + METHb)}$$

HbO_2 = Fractional Hemoglobin
COHb = Carboxyhemoglobin
METHb = Methemoglobin

Pulse Rate is calculated by measuring the time interval between the peaks of the infrared light waveform. The inverse of this measurement is displayed as pulse rate.

The Model 511 must be used in conjunction with OxySnap SuperBright™ saturation sensors. These sensors have an 8700 series part number (e.g., 8744 or 8793).

Conventions Used In This Manual 1.3

The following conventions will be used throughout this manual:

- Normal text will be shown in this type.
- Message Center alerts and displays will be shown in this type.
- The names of the front panel pushbuttons (keys) will be shown **in this type.**

Acknowledgments 1.4

SuperBright, Y-STRIP and Y-SENSOR are trademarks of Novametrix Medical Systems Inc.

2 Patient Safety

For maximum patient and operator safety, the following are recommended;

- **Failure of Operation:** If the monitor fails to respond as described, do not use it until the situation has been corrected by qualified personnel.
- Keep the Model 511 and its accessories clean.
- Do not operate the Model 511 when it is wet due to spills or condensation.
- Do not operate the Model 511 if it appears to have been dropped or damaged.
- Care should be exercised to assure continued peripheral perfusion distal to the SpO_2 sensor site after application.

> Do **NOT** attach an SpO_2 sensor distal to a blood pressure cuff. Valid data **CANNOT** be processed when the cuff is inflated. Attach the sensor to the limb opposite to the site used for the blood pressure cuff.

3 Warnings

Warning
Indicates a potentially harmful condition
that can lead to personal injury.

- **Explosion Hazard:** Do NOT use the Model 511 in the presence of flammable anesthetics. Use of this instrument in such an environment may present an explosion hazard.
- **Electrical Shock Hazard:** Always turn the oximeter off before cleaning it. Do NOT use a damaged sensor or one with exposed electrical contacts.
- **Patient Safety:** Care should be exercised to assure continued peripheral perfusion distal to the SpO_2 sensor site after application.
- **Failure of Operation:** If the oximeter fails to respond as described, do not use it until the situation has been corrected by qualified personnel.
- **Data Validity:** Do NOT attach a sensor distal to a blood pressure cuff. Valid data CANNOT be processed when the cuff is inflated. Attach the sensor to the limb opposite to the site used for the blood pressure cuff.
  - **Data Validity:** As with all pulse oximeters, inaccurate SpO_2 and Pulse Rate values may be caused by:
    - Incorrect application or use of a sensor
    - Significant levels of dysfunctional hemoglobin; carboxyhemoglobin or methemoglobin
    - Significant levels of indocyanine green, methylene blue, or other intravascular dyes
    - Exposure to excessive illumination such as surgical lamps—especially ones with a xenon light source, or direct sunlight
    - Excessive patient movement
    - Venous pulsations
    - Electrosurgical interference

4 Cautions

Caution
Indicates a condition that may lead to equipment damage or malfunction.

- Do not operate the Model 511 when it is wet due to spills or condensation.
- Do not operate the Model 511 if it appears to have been dropped or damaged.
- Never sterilize or immerse the monitor in liquids.
- Do not sterilize or immerse sensors except as directed in this manual.
- No tension should be applied to any sensor cable.
- Do not store the monitor or sensors at temperatures less than 14° F (-10° C) or greater than 131° F (55° C).
- Do not operate the monitor or sensors at temperatures less than 50° F (10° C) or greater than 104° F (40° C).
- Caution: Federal (U.S.A.) law restricts this device to sale, distribution, or use by or on the order of a licensed medical practitioner.

5 Front Panel

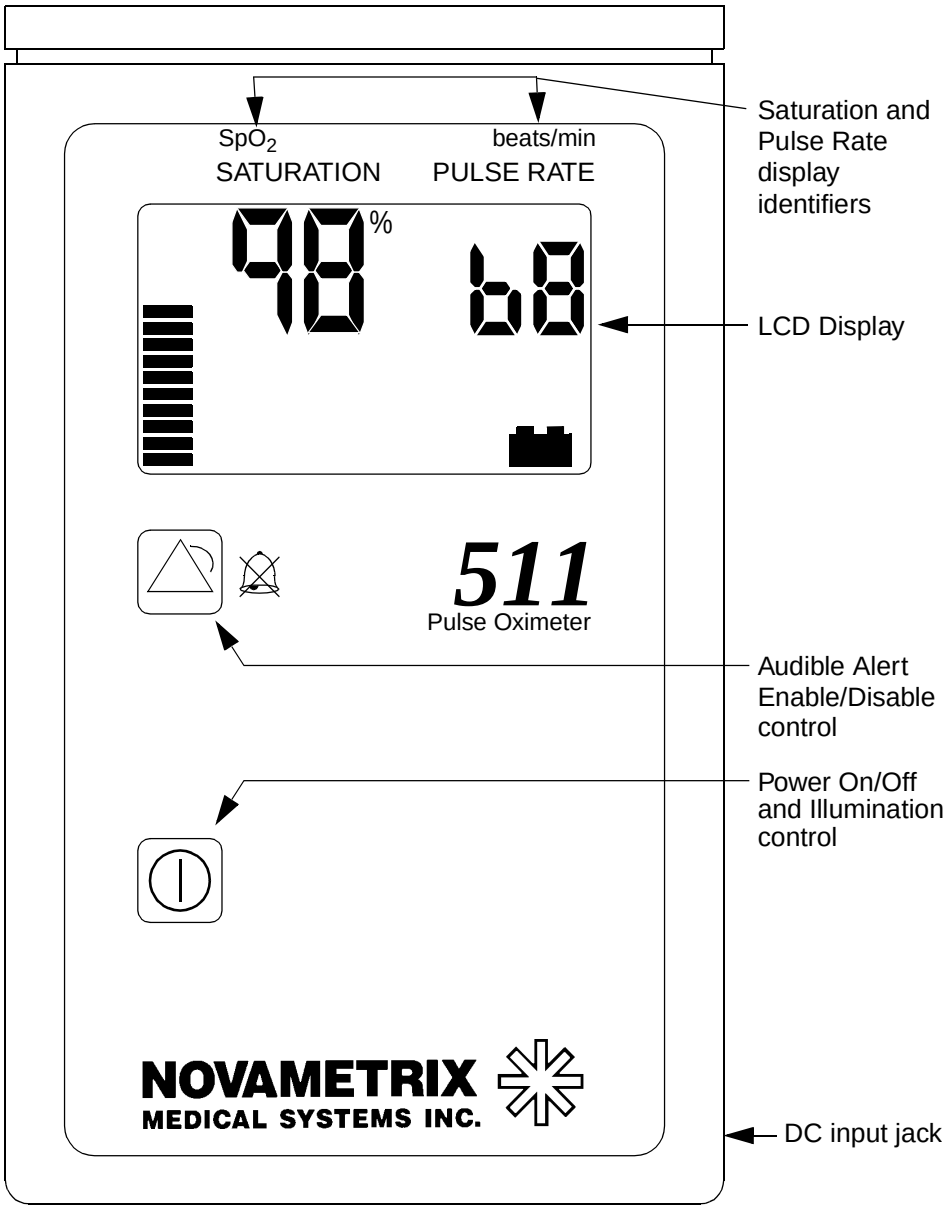


Figure 1. Front panel illustration

6 Summary of Operation

Power On/Off 6.1

1. To turn the monitor on, press the power control.

   A tone sounds to verify audio is functional, the monitor performs a system self-test, all display segments are briefly illuminated, the software version is displayed in the SATURATION section and the model number in the PULSE RATE section, and finally the operational display appears.

2. To illuminate the display for better viewability under low ambient lighting conditions, press the power control key and hold until the backlight illuminates when turning the monitor on.

   The display illumination will remain on until the monitor is turned off.

3. To turn the monitor off, press the power control.

Audible Alert Enable/Disable 6.2

1. To toggle between enabled and disabled audible alarms, press and release the alarm key.

   If pressing and releasing the alarm key causes the alarms to be enabled, the monitor shall display the saturation auto alert limit settings (in the SpO_2 and pulse rate displays) for three seconds, beep once, and turn off the alarm icon. The alarm display icon will not be displayed while audible alarms are enabled. All visible alerts continuously active for longer than 10 seconds will cause an unlatched audible alarm to sound.

   If pressing and releasing the alarm key causes the alarms to be disabled, the monitor shall beep once, and turn on the alarm icon. The alarm display icon will illuminate as a warning that the audible alarms are disabled.

2. To set alert limits, press and hold the alert key for more than 3 seconds. The monitor will beep twice if new limits are set (based on valid SpO_2 values). If no SpO_2 is displayed, the monitor will use default limits and will beep three times.

The Model 511 will display the high limit in the SpO_2 display, the low limit in the pulse rate display for three seconds. The monitor will then return to normal operation.

NOTE: Setting alert limits automatically enables the audible alarms.

To display limits without setting new limits if audio is enabled, press and release the alarm key twice. The first press turns off the alarms and the second turns then back on and causes the high and low limits to be displayed for one second. The monitor will then return to normal operation.

To display limits without setting new limits if the audio is disabled, press and release the alarm key. The high and low limits will be displayed for one second before the monitor returns to normal operation. Press the alarm key to disable the audible alarms.

Battery Life 6.3

The Model 511 displays a battery icon to indicate:

- fully charged batteries
- approximately one half the initial battery charge remains
- indicates less than 30 minutes of battery life remain.

The battery icon may appear fully charged for the first minute after power up, after which it will reflect the true battery charge. If the monitor continues operating while in the low battery state, the monitor eventually shuts itself off.

NOTE: The battery icon will remain on the display when the external DC supply is connected and powering the monitor. The icon will indicate the fully charged batteries condition, this in reality is an indication of the external DC supply, not the condition of the batteries. For proper indication of battery life the external DC supply must be unplugged from the monitor.

7 Electronic Theory of Operation

The electronic theory of operation of the Model 511 Pulse Oximeter monitor is detailed in the subsections below. Section 15, *Schematic and Assembly Drawings*, on page 59 for more information.

There are subtle differences between the first release circuit boards and the later revision, these are noted in the text with an explanation of the circuit operation.

2710 Analog Board 7.1

The 2710 Analog board contains the drive circuitry for the sensor's LEDs, the photodiode's detection circuitry, the power supply, and the turn on circuitry. The batteries and sensor are connected to the analog board, this is then connected to the 2711 digital board by two header connectors.

Power Supply 7.1.1

Power for the Model 511 Pulse Oximeter is derived from four 1.5 volt Alkaline batteries (see page 2 of schematic). These are connected to J404 on the 2710 Analog Board. Check the serial number suffix on the unit to determine the type of power up circuitry the monitor contains as described below. Different revision levels of the 2710 analog board will have differences in this circuitry.

Units with a "Z" in the serial number suffix. Power enters J404 as VBAT, F202 protects against excessive current flow. When the PWRSWIN line pulses high the N-channel FET of IC17 will be biased on, this in turn biases the P-channel portion

on and allows power to flow through to IC15. Switching regulator IC15 will supply 6.5 volts DC with an input voltage ranging from 4-6 volts DC.

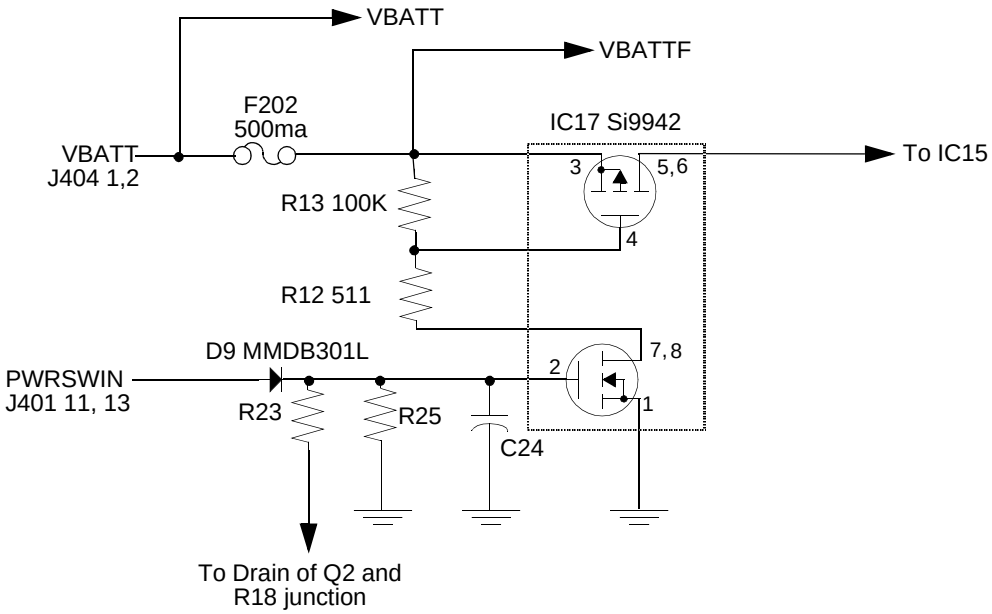


Figure 2. Revision 00 power turn on circuitry

In order to prevent F202 from blowing in the event that the batteries are installed incorrectly, a MOSFET is used. The modification is shown below.[1] Later revision boards have this modification designed in.

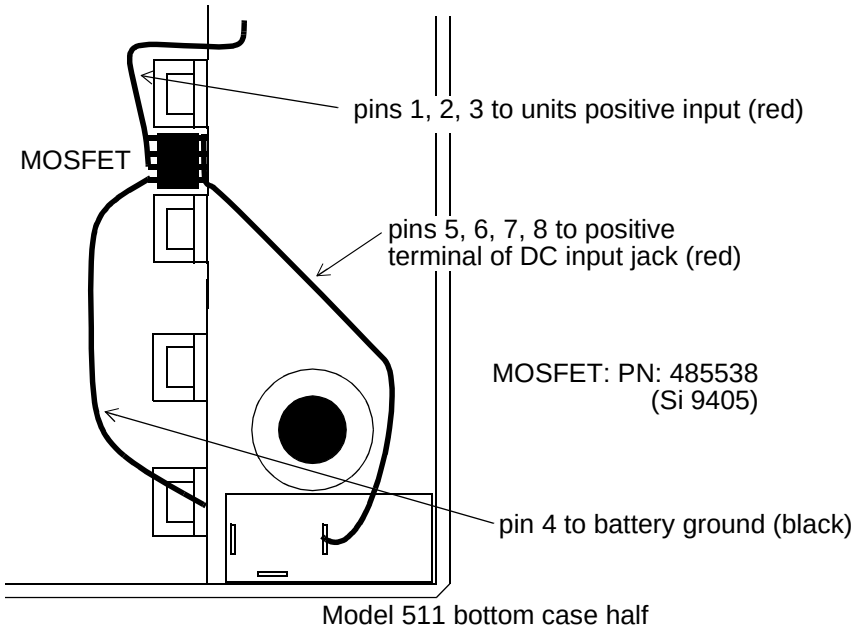

pins 1, 2, 3 to units positive input (red)
MOSFET
pins 5, 6, 7, 8 to positive
terminal of DC input jack (red)
MOSFET: PN: 485538
(Si 9405)
pin 4 to battery ground (black)
Model 511 bottom case half

Figure 3. Fuse protection modification

1. Units with this modification can be identified by a “Z” in the serial number suffix.

For units with a “W“ and/or “X” in the serial number suffix. Power enters J404 as BATTERY, provided that the batteries are properly installed, 1/2 of IC17 (pins 1, 2, 7, and 8) will be biased on. F202 protects against excessive current flow and diode D9 protects against over-voltage. When the PWRSWIN line pulses high then Q9 will be biased on, this in turn biases the second P-channel portion of IC17 on and allows power to flow through to IC15. Switching regulator IC15 will supply 6.5 volts DC with an input voltage ranging from 4-6 volts DC.

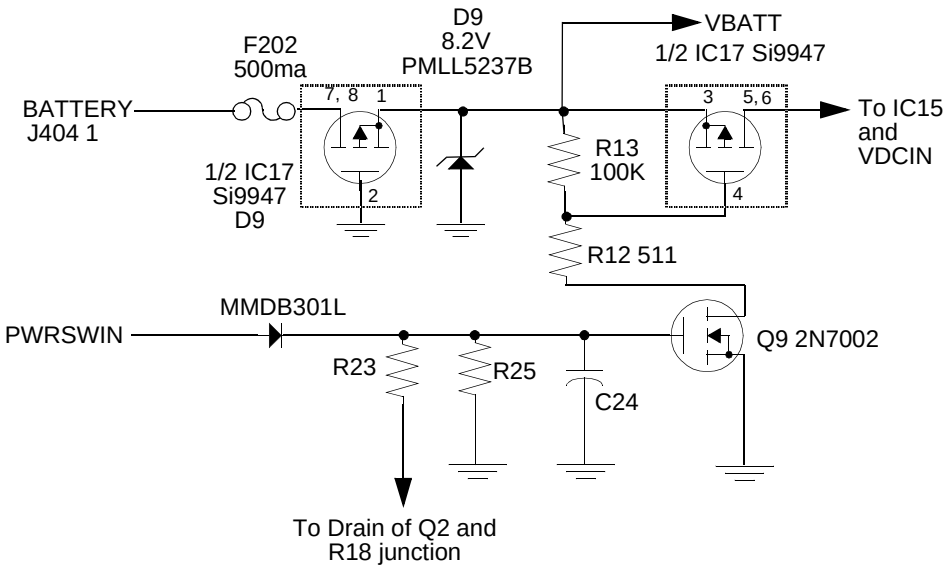


Figure 4. Fuse protection modification on newer revision boards

The VDD supply is regulated by IC10, a low drop-out voltage regulator. A DC-DC converter IC16, develops the -VA supply from the VDD supply, this is required by the operational amplifiers used in the system. The LED power (LEDSRC) is regulated and current limited by IC11, fuse F201 protects against over-current.

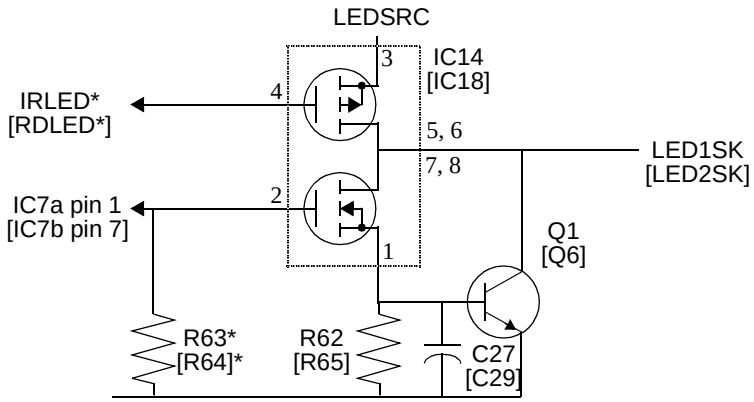
Voltage Reference 7.1.2

A positive reference voltage VREF2.5 is developed by IC9 (see page 1 on schematic), the +2.5 volts DC is derived from the +VA supply. A negative reference voltage is developed by IC13a (pin1) by inverting the +2.5 volt supply. This negative reference is -VREF at TP6. The analog to digital converter IC5 uses the VREF2.5, the -VREF is used by the digital to analog converter IC12. On revision 01 boards an alternate combination of R63 (3.92K) and D8 (LM4040 - 2.5V) may be substituted for IC9.

Sensor LED Drive Circuits 7.1.3

The drive circuitry differs between revisions 00, 01 and 02 on the 2710 board. Check the revision of the board to determine the appropriate circuitry for the unit.

The drive circuitry for earlier revision 00 boards is shown below. The diagram and description that follow explains the drive circuitry for the earlier boards. The diagram below lists the components for the red LED drive circuitry, only a portion of the circuitry is shown, refer to the schematic for components not shown. The corresponding components for the infrared channel are listed in [ ].



*May not be installed

Figure 5. Revision 00 LED drive circuitry

When the RDLED* signal goes low (logic 0), Q3 turns off and the VLED signal is divided down by R42 and R41, at IC7a (pin 3). The N-channel portion of IC14 is driven by IC7a pin 1, this will bias Q1 on when high, current will flow through the red LED in the sensor, then through Q1 and R29 to ground (the P-channel portion of IC14 is not biased on).

When RDLED* returns high (logic 1), Q3 is biased on, forcing IC7a pin3 to ground potential, this results in 0 volts at the output of IC7a (pin 1). The N-channel portion of IC14 is biased off, therefore biasing Q1 off, and as a result, the Red LED in the sensor is also off.

The Infrared LED drive circuit operates in the same manner as the Red LED drive discussed above. The IRLED* signal activates Q4 which controls IC7b, this in turn controls IC18. The source of the N-channel FET of IC18 will bias Q6 either on or off controlling the Infrared LED of the sensor.

Revision 01 boards drive circuitry is described below. Refer to the schematic for components not shown in the diagram, only the differences are displayed below. The infra-red channel components are listed in [ ].

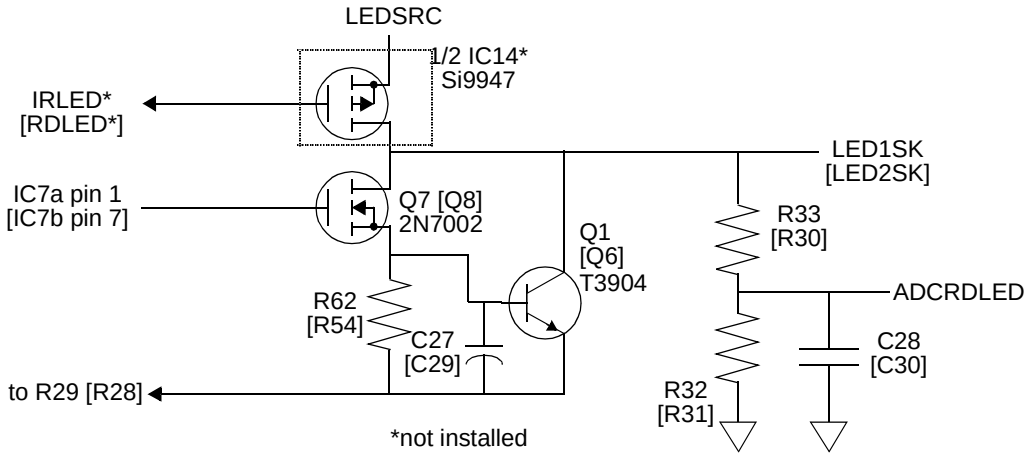


Figure 6. Revision 01 board drive circuitry

The VLED line voltage is derived from IC13b pin 7 which is controlled by the Digital to Analog Converter IC12. (See sheet 1 of 2 on schematic.) When the DACWR* line is brought Low IC12 is enabled. The data on lines D0-D7 now control the output voltage of IC13b pin 7(VLED) based on the -VREF voltage from IC13a pin 1 (TP6).[2]

When the RDLED* signal goes low (logic 0), Q3 turns off and the VLED signal is divided down by R42 and R41, at IC7a (pin 3). FET Q7 is in turn driven on by IC7a (pin 1). This will bias Q1 on and current will flow through the red LED in the sensor, then through Q1 and R29 to ground.

When RDLED* returns high (logic 1), Q3 is biased on, forcing IC7a pin3 to ground potential, this results in 0 volts at the output of IC7a (pin 1). FET Q7 is biased off, therefore biasing Q1 off, and as a result, the Red LED in the sensor is also off.

The Infrared LED drive circuit operates in the same manner as the Red LED drive discussed above. The IRLED* signal activates Q4 which controls IC7b, this in turn controls Q8. The source of Q8 will bias Q6 either on or off controlling the Infrared LED of the sensor.

The drive circuitry for later revision 02 boards is shown below. The drive is similar except that the bipolar transistor are not installed, a different operational amplifier is used, and discrete MOSFETS are used in place of the dual package used in earlier

2. On certain units pin 13 of IC12 will have a separate wire connected to J402 pin 9. This is to allow a revision 00 analog board to operate with a revision 01 digital board.

revisions. The differences between the drive circuitry are displayed below, refer to the schematic to view components not shown below.

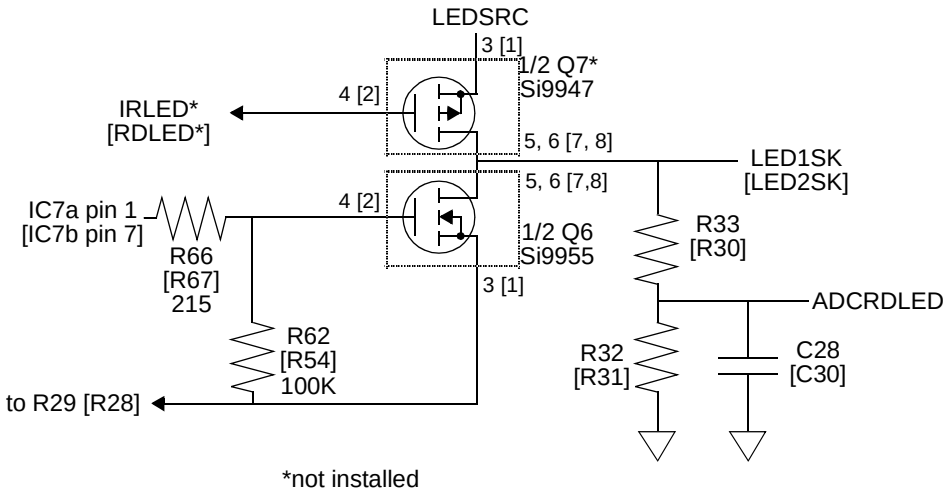


Figure 7. Revision 02 LED drive circuitry

When the RDLED* signal goes low (logic 0), Q3 turns off and the VLED signal is divided down by R42 and R41, at IC7a (pin 3). FET Q6 (pins 3, 4, 5, 6) is in turn driven on by IC7a (pin 1). Current will flow through the red LED in the sensor, through Q6, then through R29 to ground.

When RDLED* returns high (logic 1), Q3 is biased on, forcing IC7a pin3 to ground potential, this results in 0 volts at the output of IC7a (pin 1). FET Q6 is biased off, and as a result, the Red LED in the sensor is also off.

The Infrared LED drive circuit operates in the same manner as the Red LED drive discussed above. The IRLED* signal activates Q4 which controls IC7b, this in turn controls Q6 (pins 1, 2, 7, 8). The source of Q6 will control the Infrared LED of the sensor.

Sensor Photodiode Return Path 7.1.4

Light, from the sensor's Red or Infrared LED, shines through the pulsating vascular bed (the patient's finger, toe, etc.) placed between the LEDs and the photodiode. Some of this light emerges from the tissue and impinges on the photodiode, causing the photodiode to conduct current. IC4b pins 5-7 is set up as a differential amplifier that converts this input current to a voltage at the amplifier output. The sensors are wired such that photodiode current produces a positive voltage at IC4b pin 7[3].

The voltage at IC4b pin 7 is presented to an analog switch IC3b pin 6. This switch is controlled at pin8 by INSIG* (Input Signal), and will be closed (IC3b pins 6 and 7 connected) except if the monitor is in a Probe Off Patient condition or is

3. The Model 511 uses SuperBright™ sensors (part number 87xx series). If a non-SuperBright™ (Novametrix part number 86xx series) sensor is connected, IC4b pin 7 will go negative.

undergoing its Self-Test at system power up. The switch IC3c pins 9-11, controlled from SIGND* (Signal Ground) will be open (no connection between IC3c pins10 and 11) except as noted above for the switch at IC3b pins 6-8. As a result, the IC4b pin 7 voltage passes undisturbed to the high pass filter consisting of R53 and C5.

The ASAMP* signal is active whenever either sensor LED is turned on. This causes Q5 to turn off and the charge at C5 passes through to IC4a pin 3. The ASAMP* line returns to a logic high when neither LED is being driven, causing Q5 to turn on. With Q5 conducting, any charge at C5 is discharged to ground and the next pulse will charge C5 from a known level. If it were not for Q5, any charge remaining on C5 from the previous pulse or from ambient light reaching the photodiode would be added to the charge from a new pulse—creating measurement errors.

If the signal at IC4a pin 1 is the product of the Red LED being turned on, then RDSAMP* will go low and close the switch at IC3a pins 2-3, thereby presenting the signal to a sample and hold circuit consisting of R17 and C8 (that maintains the signal until next sample pulse arrives), a gain stage, (IC2b), a filter/divider network (C7, R14 and R55), and finally, to the Red channel Analog-to-Digital Convertor (ADC) IC8.

If the signal at IC4a pin 1 is the product of the Infrared LED being turned on, then IRSAMP* will go low and close the switch at IC3d pins 14-15, thereby presenting the signal to a sample and hold circuit consisting of R6 and C4 (that maintains the signal until next sample pulse arrives), a gain stage, (IC2b), a filter/divider network (C3, R3 and R54), and finally, to the Infrared channel Analog-to-Digital Convertor IC1.

Calibrating the 20-Bit Analog-to-Digital Convertors 7.1.5

The 20-bit ADCs are calibrated as part of the system self-test which occurs each time the monitor is turned on. At power up, the microprocessor sets the CAL line high. The System Calibrations input SC1 is set high. The CS5503 ADC will not operate while the CAL line is high. On the falling edge of the CAL signal, the ADC will initiate a calibration cycle determined by the state of the SC1.

The high at SC1 causes INSIG* to go high and reset SIGND* to a logic low. The high INSIG* opens the switch at IC3b pin8 so that IC3b pins 6 and 7 are no longer connected—disconnecting the returning photodiode signal from the rest of the circuitry. The low SIGND* signal closes the switch at IC3c pin9 and as a result, the input to the C5-R53 high pass filter (and thus the entire ADC input circuitry) is brought to ground potential.

The CAL line (which went high at power up) is reset low and ADCs IC1 and IC8 begin their calibration cycles. Because the analog input circuitry is grounded via SIGND*, only circuit offset voltages can be present at the (pin 9 AIN) inputs. The calibration cycle sets the ADC “zero” point to equal this voltage, thus compensating

for any circuitry offsets. The ADC then sets its "full scale" point to equal the voltage at its VREF (pin 10) input. This completes the calibration cycle.

The ADC can now start sampling its input and converting it to a 20-bit digital word. The processor resets SC1 to a logic low, causing IC3c pin9 to open and IC3b pin8 to close. The photodiode signal can now reach the ADCs. See *Sensor Photodiode Return Path* on page 14.

20-Bit Analog-to-Digital Conversion 7.1.6

Data from the Red and Infrared channels is sampled by the 20-bit measurement ADCs, IC1 and IC8 respectively. The analog input at pin 9 is converted to a digital representation with 20-bit resolution based on the input magnitude.

The CS5503 convertor continuously samples its input, converts the value to a digital word, puts the word in its output buffer (overwriting previous buffer contents), then repeats the process by again sampling its input. The frequency of the sample/convert/overwrite-buffer sequence is based on the 3.2768 MHz clock signal at the ADC pin 3 (ADCCLK) input.

The microprocessor starts a read cycle of the Infrared channel by bringing IC1 pin 16 (Chip Select Channel 1) low. A Red channel read starts when IC8 pin 16 (Chip Select Channel 2) is brought low.

On the falling edge of the ADC's CS*, the output word's MSB (most significant bit) appears at the pin-20 SDATA (Serial Data) output. The SDATA line connects directly to the microprocessor's serial input (RXS) pin. The remaining bits (in descending order) are output from SDATA with subsequent falling edges of the Serial Clock (SCLK) input at pin 19. The SDATA output automatically goes to a 3-state (high impedance) condition after completing a word transmission, thus freeing the data line for other uses (i.e., the other ADC channel).

The Serial Clock speed is controlled through the digital board. This clock rate is significantly slower than the ADC sampling rate. As a result, the ADC rewrites its output buffer with new information at a faster rate than the data can be read from the buffer. No conflict occurs, however, because while CS* is low (during the read cycle), the ADC does not update its output buffer—the current word is not overwritten. After the processor receives the entire word, it allows the convertor's CS* to return high, and the ADC resumes its sample/convert/overwrite-buffer cycle.

Sensor Status Decoding and Conversion 7.1.7

The microprocessor monitors several sensor parameters in addition to the Red and Infrared data channels. It monitors the status parameters, as well as the voltage of the monitor's internal battery.

The 8-to-1 multiplexor, IC6, decodes the A0MUX-A2MUX input address lines and connects one of eight status parameter inputs to the multiplexor output at IC6 pin 3. Resistor R38 and diode D5 prevent negative voltages from reaching the input to the analog-to-digital convertor, IC5.

IC5 is an 8-bit analog-to-digital convertor with a serial data output. While the IC5 Chip Select (ADC3CS*) input is high, the CLK input and ADC3DOUT output are in 3-state mode. When $\overline{CS}$ is brought low (under processor control), the most significant bit (D7) of the *PREVIOUS* data conversion becomes available at the ADC3DOUT pin. The remaining bits (D6-D0) are shifted out on subsequent falling edges of the CLK input. On the clock pulse following the one that shifts out the least significant bit (D0), the CLK and ADC3DOUT lines are returned to 3-state and the ADC performs a new conversion based on the input it receives from the IC6 channel selected by the A0MUX-A2MUX input address lines.

The ADC sample/convert/store-result cycle is based on internal chip timing and not the CLK input which (along with $\overline{CS}$) only controls serial data output. Thus the $\overline{CS}$ line is free to return high once the ADC cycle begins.

Sensor Status Parameters 7.1.8

The sensor (and battery) status parameters input to the multiplexor IC6 are described below.

ADCVRD: This signal is not used as of this writing.

ADCVIR: This signal is not used as of this writing.

ADCFEDC: Photodiode DC Level.
Resistors R19, R20 and capacitor C13 form a voltage divider and low pass filter that provide a measure of the mean DC level at the output of the photodiode current-to-voltage amplifier IC4b pin 7. This signal is used in determining ambient light interference. If this line is examined while the sensor's Red and Infrared LEDs are turned off, then any DC level at IC4b pin 7 must be the result of ambient light impinging on the photodiode. If the DC shift is in excess of limits set in the software, a Light Interference message appears on the monitor's display.

ADCLPWR: Sensor LED Supply Voltage.
This channel, at IC6 pin 12, monitors the sensor LED supply voltage through a voltage divider consisting of R26 and R27. If a fault occurs that causes the LED supply fuse F2 01 to blow, or if the sensor wires are shorted, this channel reports the condition and the monitor will indicate an error condition.

ADCIRLED: Infrared LED Cathode Voltage.
A low pass filter consisting of R30, R31 and C30 provides a means to measure the cathode voltage of the sensor's Infrared LED. If the channel at IC6 pin 5 is sampled the monitor can determine if the LED is open circuit (zero volts at IC6 pin 5) or operational (approximately 2.5 volts at IC6 pin 5).

ADCBATT: Battery Supply Voltage
The monitor's battery voltage is divided down by R15 and R16. The voltage at IC6 pin 2 is monitored and if its magnitude is less than a predetermined value (encoded in the software) the monitor indicates a low battery warning.

ADCRDLED: Red LED Cathode Voltage.
A low pass filter consisting of R33, R32, and C28 provides a means to measure the cathode voltage of the sensor's Red LED. If the channel at IC6 pin 4 is sampled the monitor can determine if the LED is open circuit (zero volts at IC6 pin 4) or operational (approximately 2.5 volts at IC6 pin 4).

2711 Digital Board 7.2

The microprocessor, memory, display driver, and supportive digital circuitry is all contained in the 2711 digital board. Mounted on the digital board is the Liquid Crystal Display (LCD), the Keypanel connects to the 2711 board at J405.

Microprocessor and Memory 7.2.1

The Model 511 is controlled by IC1, an 8 bit microprocessor running at 6.14 MHz. Crystal Y1 controls the operating frequency, system address lines are labelled as A0-A17, system data lines are labelled D0-D7.

The system program is contained in IC3 a 27C512 EPROM (or 27C101), when both RD* and ROMCS* are low a read operation is performed on IC3. The ROMCS* line is controlled by the ME* line (Memory Enable) and address line A17. When both the ME* line and address line A17 are low the ROMCS* line will go low (IC9 pin 6), this enables IC3.

System RAM is contained in IC2. When both the RD* and RAMCS* lines are brought low a read operation is performed on IC2. With both WR* and RAMCS* low a write operation will be performed. The RAMCS* line is controlled by the ME* (Memory Enable) line and address line A17. When address line A17 is brought high, and the ME* line brought low, IC9 pin 3 will go low activating the RAMCS* line.

For revision 00 boards the operation is as follows: System RAM is contained in IC2. When both the RD* and PRAMCS* lines are brought low a read operation is performed on IC2. With both WR* and PRAMCS* low a write operation will be performed. The PRAMCS* line is controlled by the ME* (Memory Enable) line and address line A17. When address line A17 is brought high, and the ME* line brought low, IC9 pin 3 will go low. This will bias Q3 on and the PRAMCS* will be brought low enabling the chip select of IC2. The purpose of Q3 is to isolate the

PRAMCS* line from VDD when power is turned on or off, this will avoid spurious oscillations from inadvertently enabling the chip.

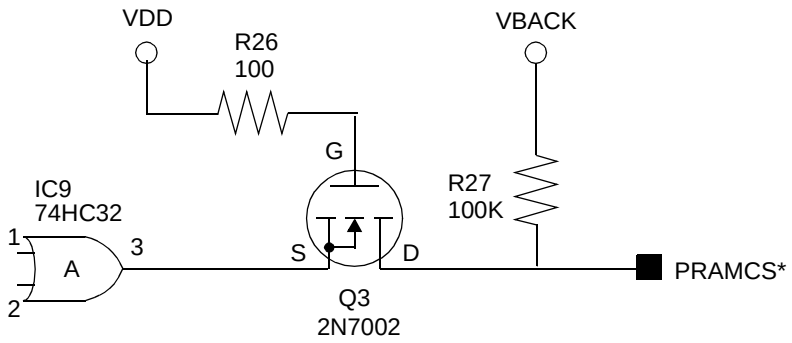


Figure 8. Revision 00 PRAMCS* configuration

Decoding 7.2.2

A three to eight line decoder IC11, is used for decoding various write, enable, and interrupt lines for the system. Address lines A4, A5, A6, and A7 will enable one of the Q outputs of IC11. The table below lists the lines that are controlled by IC11, the WR*, DISPLED, and PWRSWIN lines.

Name	Function
DACCS* [DACWR* for rev 00 boards] Digital to Analog Controller Write	This line will enable writing to IC12 on the 2710 Analog board.
RTCCS* Real Time Clock Chip Select	This line corresponds to the Q1 output of IC11 and is used for the optional printer for time stamping on printouts.
DISPWR* Display Write	When both the processor's WR* line and the DISPCS* line from IC11 are low the DISPWR* line will initiate a write to the display controller IC4.
DISPCS* Display Chip Select	This line enables the display controller IC4 for writing.
SPCS3* Serial Printer Chip Select #3	This line is sent to the printer option and corresponds to the Q3 output of IC11.
INT1* Interrupt #1	This interrupt line is controlled by the INTCS* line from IC11 and the DISPLED line. The DISPLED line will be brought low when the front panel ☼ key is pressed. This activates the backlight on the display.

Table 1. 2711 digital board decoding lines

Name	Function
PWRNMI* Power Non-Maskable Interrupt	This line turns the monitor off. When the PWRSWIN line is brought high (by pressing the front panel POWER key) and the INTCS* line is low, the PWRNMI line will signal the processor to shut off.
PORT1WR Port #1 Write	This line is controlled by the WR* line of the processor and the PORT1CS* line from IC11. It enables writing to IC12, this controls the multiplexor lines, SC1 and CAL lines for the 20 bit A/D Converters, nad control lines for IC7.
PORT2WR Port #2 Write	Controlled by the WR* line and PORT2CS* from IC11. This line will enable writing to IC14. The SPOUT lines (for serial printer), 20 bit A/D converter sleep line, backlight control, and power off control are handled by IC14.
SPCS7* Serial Printer Chip Select #7	This line is sent to the printer option and corresponds to the Q7 output of IC11.

Table 1. 2711 digital board decoding lines

Microprocessor Supervisor 7.2.3

A microprocessor supervisory integrated circuit, IC5 monitors the power supply, and shuts the monitor off when the front panel power key is pressed. When the PWROFF line is brought high (under control of the processor) Q1 will be biased on. The PFI input of IC5 will in turn be brought low, this will cause the PWROFF* line to go low. The PWROFF* line will shut the monitor off by biasing Q2 (located on the 2710 Analog Board) on, this in turn shuts the power off on the monitor, see Section 7.1.1, *Power Supply*, on page 9. The MRIN* (Manual Reset In) line enables an external device to reset the system if brought low, this line enters the system at J2 pin 15 (see page 2).

The WDOG line under control of the processor must be toggled before a specific time-out (1.6 seconds) otherwise the RESET* line is brought low, this will result in the system resetting. Therefore the processor toggles the WDOG line periodically to avoid the reset, this ensures that the processor is working and not lost in a loop or task. If the VDD supply drops below a certain level the RESET* line will also be brought low to reset the system.

For revision 00 boards: The microprocessor's supervisor (or watchdog) is made up of IC5 and IC6. The battery voltage is converted to a 2.5 volt reference by IC6, this is used as the backup supply when the monitor is off. When the monitor is powered on and VDD is at +5 VDC the VBACK supply is taken from VDD, when the

monitor is off the VBACK supply is taken from VBAT (the 2.5 volt reference), this switching is controlled by IC5.

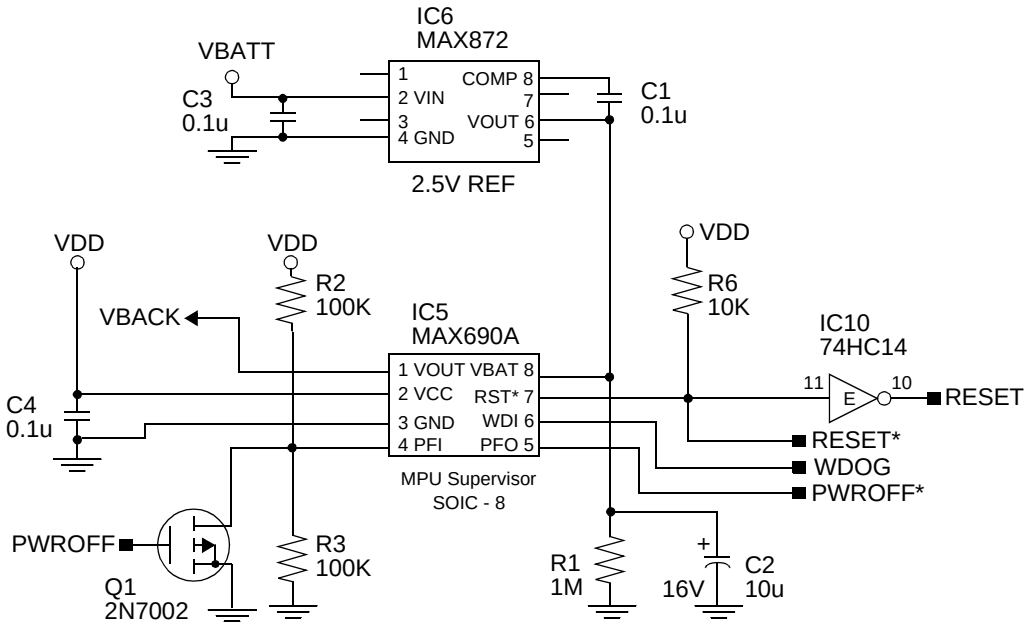


Figure 9. Revision 00 watchdog circuitry

When the PWROFF line is brought high (under control of the processor) Q1 will be biased on. The PFI input of IC5 will in turn be brought low, this will cause the PWROFF* line to go low. The PWROFF* line will shut the monitor off by biasing Q2 (located on the 2710 Analog Board) on, this in turn shuts the power off on the monitor, see Section 7.1.1, *Power Supply*, on page 9.

The WDOG line under control of the processor must be toggled before a specific time-out (1.6 seconds) otherwise the RESET* line is brought low, this will result in the system resetting. Therefore the processor toggles the WDOG line periodically to avoid the reset, this ensures that the processor is working and not lost in a loop or task. If the VDD supply drops below a certain level the RESET* line will also be brought low to reset the system.

Front End Timing Signals 7.2.4

A 14 stage divider IC6 (IC15 on rev 00 boards), acts as a timing sequencer. The ADCCLK input is the clock input, the RESET line is the clear input, used for clearing the chip at power up. The Q4-Q11 outputs of IC6 are divided down from the clock input and feed IC13, the data sampling controller. The Q14 output of IC6 is used as an interrupt that is generated every 5 milliseconds (INT5MS).

The data sampling controller IC13 is a Programmable Electrically Erasable Logic device (PEEL). The PEEL uses the outputs from IC6 (IC15 on rev 00 boards) and

generates the front end timing signals. These signals control the sensor LED drive and the photodiode's return path circuitry during normal operation and calibration.

The RESET and SC1 lines control when the outputs of IC13 are active, both these lines must be low in order for IC13 to operate normally. The RESET line controls IC13 during power up, while the SC1 line is under processor control and will toggle when a probe off patient alert exists and during the power up self test.

Signal	Description
INSIG* Input Signal	This line will enable signals from the photodiode, or prevent signals from the photodiode from reaching the detection circuitry.
RDLED* Red LED	Controls the signals for the Red Led in the sensor.
IRLED* Infrared LED	Controls the signals for the Infrared Led in the sensor.
SIGND* Signal Ground	This is used to short out the inputs of the detection circuitry so that the system can compensate for offsets.
ASAMP* Analog Sample	This line is used to short out the capacitor used in the sample and hold circuitry to avoid having residual charge interfere with data sampling.
SYNC Synchronization	Synchronization signal, not used in this system.
IRSAMP* Infrared Sampling	Used for sampling the Infrared signal response from the photodiode.
RDSAMP* Red Sampling	Used for sampling the Red signal response from the photodiode.

Table 2. Front end timing signals

System Output Ports 7.2.5

There are two output port chips IC12 and IC14, these control various lines for system control. The first port IC12, enabled when PORT1WR is high controls the CSIO PEEL IC7, the analog multiplexor IC6 on the 2710 board, and the 20 bit analog to digital converters IC1 and IC8 on the 2710 board. The second port IC14, enabled by the PORT2WR line, handles the serial printer control lines ADCSLP*, SPOUT1-SPOUT3, the DISPBLK* and BKLITE lines that control the display. The second port also controls turning the monitor off through the PWROFF line.

The output ports are selected by the decoding performed by IC11 and the WR* line. The signals controlled by the ports are listed below with a brief description of their function.

Signal	Description
AA0-AA1	Decode line for selecting ADCs.
SC1	Used for 20 bit ADC calibration.
CAL	De-activates the 20 bit ADCs prior to calibration.
A0MUX-A1MUX	Selects one of six channels that will be switched to the serial A/D converter for conversion.
NEXT*	Used in decoding selection of ADCs.
ADCSLP*	Signal used for the serial printer.
BKLITE	Controls the backlight for the LCD display.
PWROFF	Turns the monitor off, under processor control.
DISPBLK*	Blanks out the display by de-activating IC4.
SPOUT1-SPOUT3	Used for the serial printer option.

Table 3. Output port lines

Serial I/O Controller 7.2.6

Digital data from the three Analog-To-Digital Convertors is read by the CPU through its clocked serial data input (RXS) at IC1 pin 56. The PEEL IC7 acts as the Clocked Serial Input/Output (CSI/O) Controller.

Except during power up or Watchdog Timer reset, IC6 (IC15 on rev 00 boards) pin 3 provides an interrupt to the CSI/O controller in the form of a 5 millisecond period square-wave input to IC7 pin 7 (INT5MS).

On the rising edge of INT5MS, a CPU interrupt request is generated when IC7 pin 18 (CPUINIT*) goes low. The CPU responds by sending the clock input to CSI/O controller (CKS) at IC7 pin 6 low. (This CKS line is inactive high unless a serial receive operation is in progress.) The CPU also sets up the ADC decode lines AA1 and AA0 at IC7 pins 5 and 4, and as a result, one of the ADC chip select lines (ADCIRCS*, ADCREDCS*, ADC3CS*) is brought low, and the CPUINIT* line is disabled.

On the rising CKS signal a CLKS output pulse at IC7 pin 14 is sent as a serial clock input to the ADC selected by the decode lines. Decode results are shown below.

AA1	AA0	Decode
0	0	Red LED 20-bit ADC
0	1	Infrared LED 20-bit ADC

Table 4. CSI/O decode lines

AA1	AA0	Decode
1	1	Sensor Status 8-bit ADC
1	0	Internal CSI/O signal (TEND)

Table 4. CSI/O decode lines

Successive CKS/CLKS pulses cause the ADC data to be shifted out of the ADC (most significant bit first) along the serial data line (SDATA) to the CPU serial input (RXS) at IC1 pin 56.

After receiving the correct number of bits for the ADC being read, the CPU changes the AA1 and AA0 decode lines and exerts the Next line (NEXT*) at IC12 pin 12 low. This restarts the serial data shifting out of the newly selected ADC.

After all three ADCs have been read, the CPU sets the AA1 and AA0 decode lines to exert the internal TEND signal and set the 8-bit ADC to the next channel (so that it has time to settle before the next read of the ADC). This re-enables the CPUINIT line. At this point the CSI/O controller is reset awaiting an INT5MS pulse to begin the cycle again.

Display 7.2.7

The display is interfaced to the microprocessor by IC4, a Liquid Crystal Display (LCD) decoder/driver. The DISPWR* line will enable IC4 on its positive going edge. Parallel operation is performed on the address lines A0-A1, and data lines D0-D3.

VDISP: Display Voltage Control, when this input is brought to a lower voltage than one volt from VDD the display will be shut down. This is accomplished when the DISPBLK* line is brought low, Q2 will be biased off and the VDISP line voltage will be close to VDD. When the DISPBLK* line is high then Q2 is on, current will flow through D3-D7 (diodes are used for temperature compensation), through the parallel combination of R9 and R12 then through Q2 to ground. The voltage at VDISP will be about 2 volts and the display will operate.

The backlight for the display is controlled by the BKLITE line (IC14 pin 18). When BKLITE is brought high both Q5 and Q4 (Q6 on the rev 00 boards) will be biased on, this will allow current to flow through DS1 and DS2, the display will light.

8 Maintenance

General 8.1

This section presents recommended maintenance schedules for the Model 511 and information on general maintenance, such as battery replacement, disassembly and assembly instructions, and system software updates.

Maintenance Schedules 8.2

The electronic circuits within the Novametrix Model 511 Pulse Oximeter monitor do not require scheduled calibration or service. However, in order to maximize battery life, the monitor's internal battery should be exercised monthly. Novametrix recommends the following maintenance schedules.[1]

- Cleaning and Sterilization:
  Perform as required. See *Cleaning and Sterilization* on page 26.
- Battery Installation:
  See *Battery Installation* on page 26.
- Functional Test:
  Perform on each Model 511 and sensor to verify overall functional integrity of the monitor and sensors. See *Functional Test* on page 35.
- Accuracy Test:
  This test, which requires the use of the Model TB500B Sensor Simulator, verifies the performance accuracy of the Model 511. This test is typically performed in conjunction with (after) the Monitor Functional Test. If the monitor does not pass the accuracy test, the Electronic test should be performed. See *Accuracy Test* on page 39.
- Electronic Tests:
  These tests contain information on checking the electronic circuits within the Model 511 and should only be performed if the monitor fails to pass the Functional and/or Accuracy Tests. Only qualified service personnel should attempt to perform the Electronic Test. See *Electronic Test* on page 43.

1. At the customer's request, Novametrix will provide repair and calibration services under the terms of a Service Contract. Contact the Novametrix Service Department for contract details.

Cleaning and Sterilization 8.3

Model 511 Monitor 8.3.1

- Turn the monitor off before cleaning.
- Clean the monitor surface with a damp cloth.
- Do not immerse the monitor.
- Do not attempt to sterilize the monitor.

Finger Sensor 8.3.2

- Clean the sensor surface with a damp cloth.
- Ensure the sensor windows are clean and dry.
- Do not immerse the sensor.
- Do not attempt to sterilize the sensor.

Y-SENSOR™ and Y-STRIP™ Taping System 8.3.3

- The Y-SENSOR may be immersed (up to the connector) in a cold liquid sterilant (i.e., Cidex™). Refer to sterilant manufacturer's instructions and standard hospital protocol.
- Rinse thoroughly with water and dry before use.
- Do not immerse Y-SENSOR connector.
- Treat Y-STRIP Taping System in accordance with hospital protocol for single-patient use.

Battery Installation 8.4

The Model 511 operates on four (4) 1.5 volt "AA" alkaline batteries. Other battery types should not be used with the monitor.

WARNING: Use of improper batteries may present a risk of fire or explosion.

To install batteries into the monitor:

1. Locate the battery compartment cover on the back side of the monitor.
2. Press the "OPEN" area of the compartment cover, slide the cover in the direction indicated by the arrow, and remove the cover.

3. Install new batteries according to the "+" and "-" symbols on the bottom of the battery compartment and on each battery.

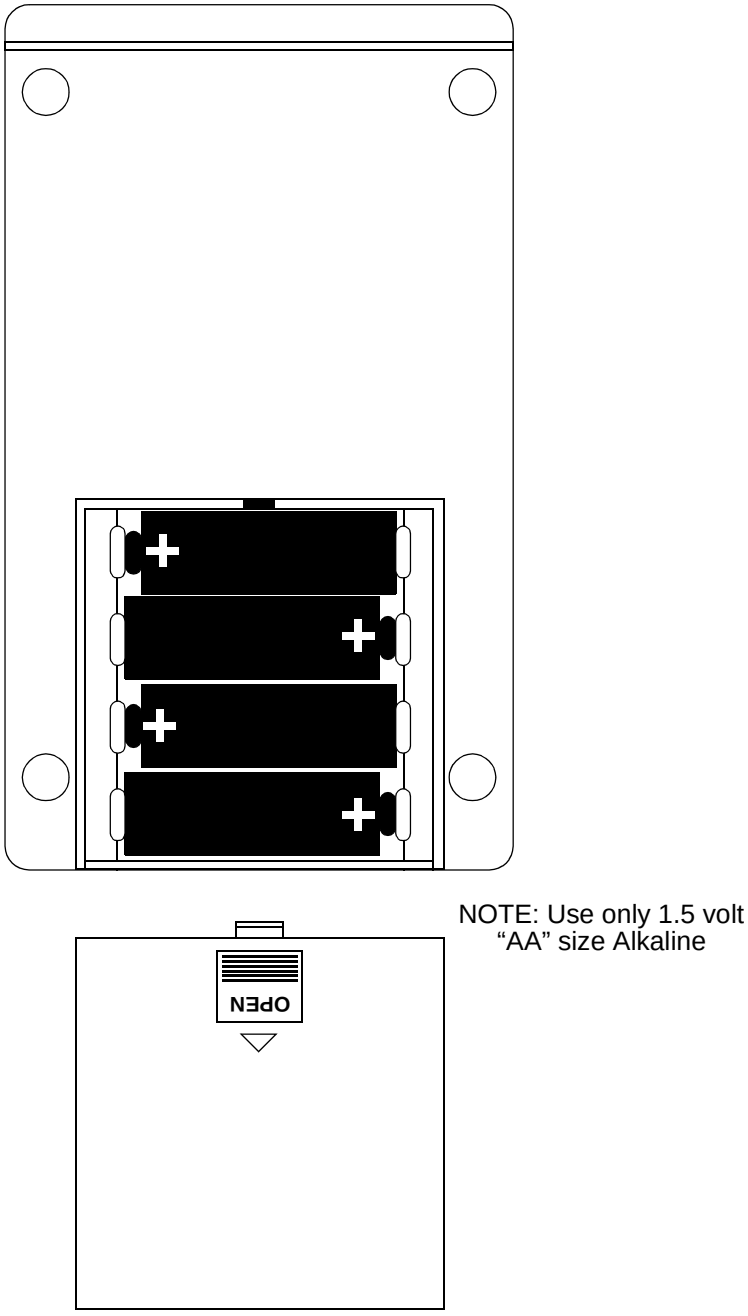


Figure 10. Battery orientation

WARNING: Alkaline batteries may explode or leak if recharged, inserted improperly, or disposed of in a fire. Do not open batteries.

4. Slide the battery cover back into place. The cover latches into place when properly seated.

Assembly Exchanges 8.5

Disassembly should be performed by qualified personnel. Follow proper grounding procedures to avoid damage to internal components from static discharge.

1. Turn the Model 511 Off. Disconnect the sensor, external DC supply if connected, and remove the batteries. Remove the four cover screws from the bottom cover. Holding both case halves together, flip the monitor right-side up.

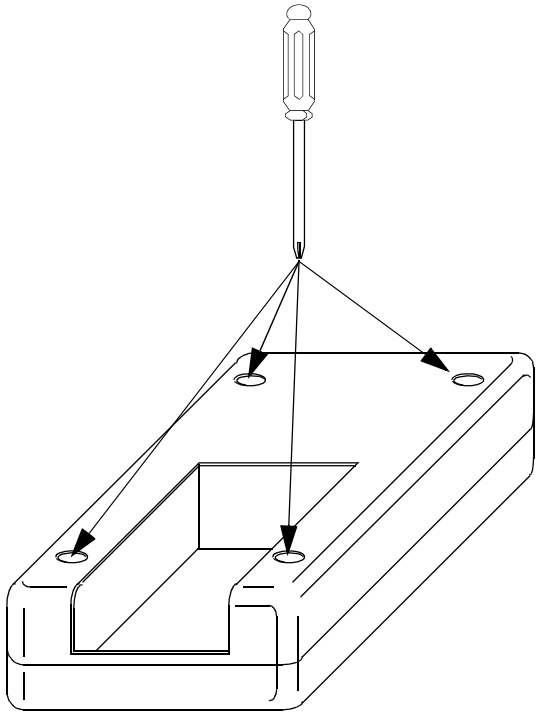


Figure 11. Removing the top cover

2. Use a gentle rocking motion to separate the left side first, lift the top cover from the monitor. Be careful of the keypanel ribbon cable, it is attached between the top cover and digital board.

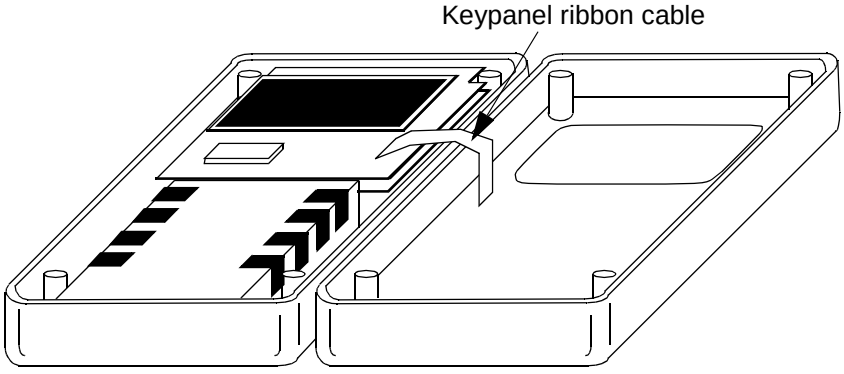


Figure 12. Monitor disassembled

3. Carefully disconnect the keypanel ribbon cable from the display board. Carefully pull the sliding portion of the connector upward, this will release the ribbon cable.

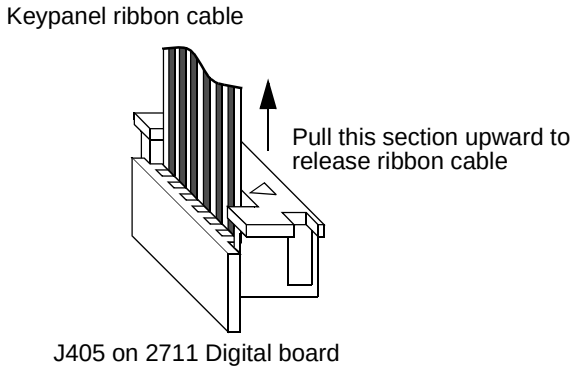


Figure 13. Disconnecting keypanel ribbon cable.

4. The circuit boards of the monitor can now be removed from the bottom case assembly. Be careful not to damage the speaker or battery wires.
5. Remove/replace the various assemblies as needed. IMPORTANT: The monitor *will be damaged* if power is applied to it while cables or assemblies are improperly connected.

Changing System Software 8.6

The system software is contained in EPROM IC3 on the 2711 Digital Board. New software releases are made available from time-to-time. These new releases may add features or be maintenance upgrades. To install a new EPROM:

1. Follow the steps listed in *Assembly Exchanges* on page 28 to open the monitor. Be sure that the external DC supply is disconnected, and batteries are removed from the unit before disassembly.
2. Use a small flat-blade screwdriver (or IC extraction tool) to pry the EPROM IC3 from the socket—be careful not to bend the pins.

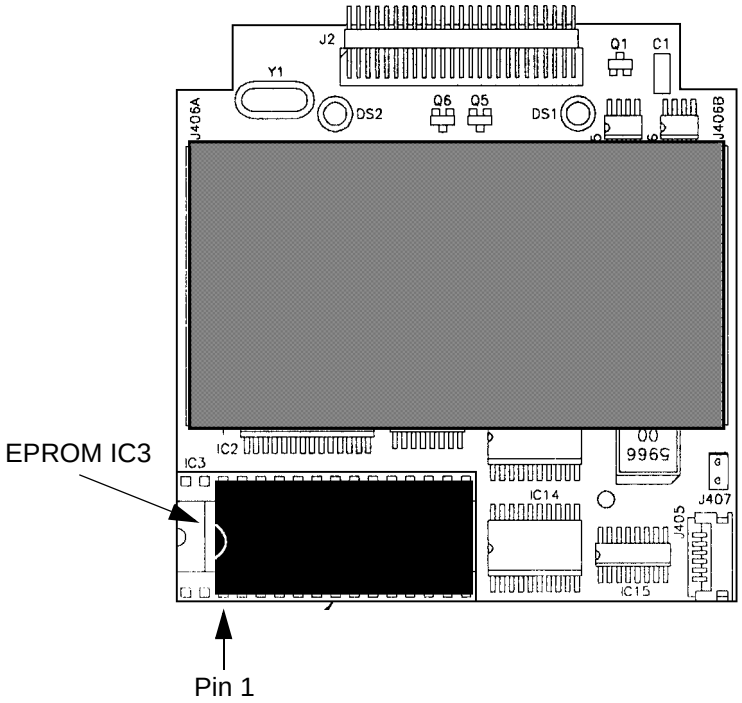


Figure 14. Changing the system software EPROM

3. Install the new EPROM into the socket. Align the EPROM so that IC3 pin-1 is properly aligned with the socket.
4. Reassemble the monitor.

9 Status Messages

The information listed below constitute the various fault, alert, and status messages that can be indicated by the Model 511 display.

Status Messages and Fault Indicators 9.1

The Model 511 Pulse Oximeter can indicate messages as text in conjunction with numerical codes on the display. This combination will correspond to specific conditions that are explained in the following table.

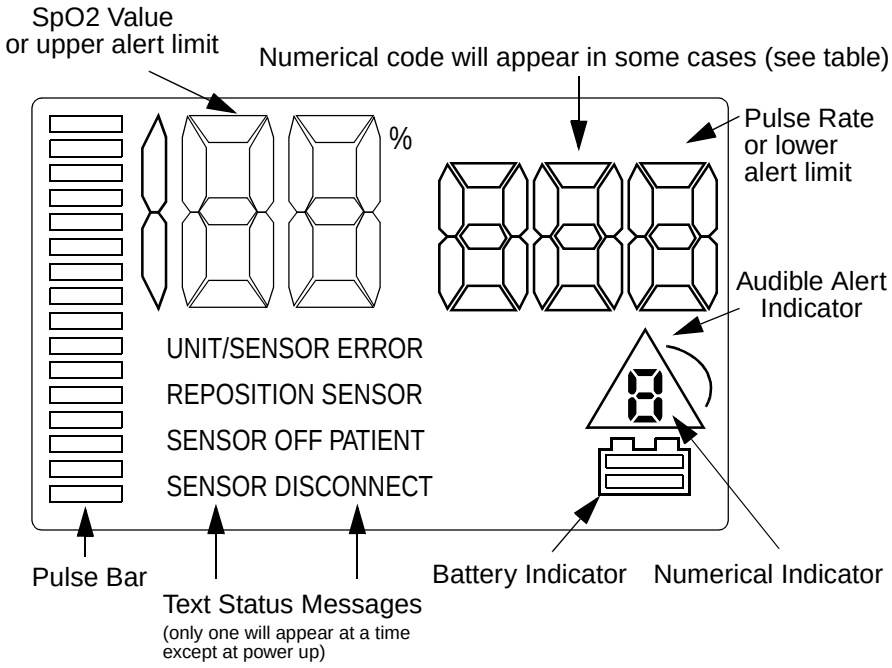


Figure 15. Status messages and numerical codes

Text Message	Numerical Indicator	Explanation
Sensor Disconnect	1	Sensor not connected to monitor.
Sensor Off Patient	2	Sensor not applied to the patient.
Reposition Sensor	3	Low signal strength. Pulse strength as detected by the sensor is too small for proper monitor operation.
Reposition Sensor	4	Insufficient light. Sensor placed on a site too thick (or opaque) for adequate light transmission.
Reposition Sensor	5	Pulse out of range. Pulse must be 30-250 bpm inclusive.
Reposition Sensor	6	Light Interference. Ambient light sources (sunlight, warming lights, etc) are interfering with sensor operation. Shield sensor from these light sources.
Unit/Sensor Error	7	Sensor fault. Remove sensor from use and contact qualified service personnel.
Unit/Sensor Error	8	Monitor fault. Record the error number that appears in the PULSE RATE display. Remove the monitor from use and contact qualified service personnel.
Reposition Sensor	9	Bad signal time-out. Monitor not receiving valid signals from sensor, reposition sensor.

Table 5. Status messages

All status conditions except for Unit/Sensor Error will reset automatically once the condition is corrected. Unit/Sensor Error conditions are latching conditions—that is you must replace the sensor for a sensor fault, or turn the Model 511 off and fix the problem before the monitor fault is reset.

If the Unit/Sensor Error message appears and status triangle numerical indicator is 8, then another numerical code will be displayed in the PULSE RATE display. The numerical codes with the error detected is listed below.

PULSE RATE Numerical Code	Explanation
1	RAM Self Test Failed
3	ROM Self Test Failed
10	Stack pointer error-not at top of stack
11	MMU error-not at base page
12	250 ms interrupt-illegal task

Table 6. Error codes

PULSE RATE Numerical Code	Explanation
13	Stack error-stack overflow
14	Display buffer overflow
15	Front end offset error
20	10 ms overrun
21	250 ms overrun
22	illegal int1 interrupt
23	illegal int2 interrupt
24	illegal prt1 interrupt
25	illegal dma0 interrupt
26	illegal asc0 interrupt
27	illegal nmi interrupt
28	Trap error-illegal command executed
40	Unknown error

Table 6. Error codes

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10 Functional Test

Introduction 10.1

The Functional Test described below should be performed on each Model 511 Pulse Oximeter and sensor to verify overall functional integrity of the monitor and sensors. If the monitor or sensors do not pass these tests, remove from use and contact the Novametrix Service Department for repair/replacement assistance.

Monitor Functional Test 10.2

1. Equipment Required:
   Model 511 to be tested (with fully charged batteries)
   Finger Sensor (Cat. No. 8744) or Y-Sensor™ (Cat. No. 8793)
2. Check that the sensor is not connected to the monitor. Press and hold the ⏻ key on the front panel until the display backlight illuminates, verify the monitor powers up; all segments should activate, then the display should show SENSOR DISCONNECT and the number 1 will flash, both SATURATION and PULSE RATE displays should be blanked.

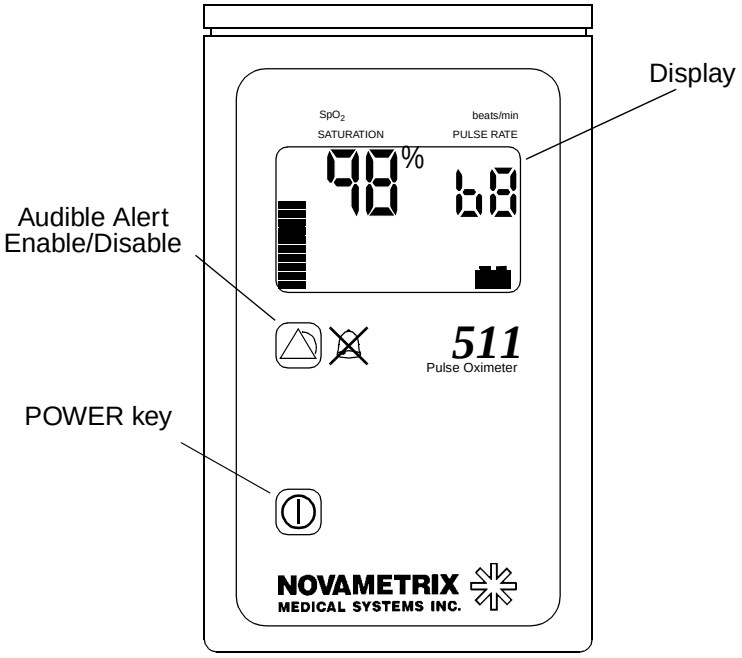

Figure 16. Front panel

3. Connect the sensor, verify SENSOR OFF PATIENT and the number 2 flashes. If using the Y-Sensor, position the sensor heads so that they face each other (the red light shines at the detector).

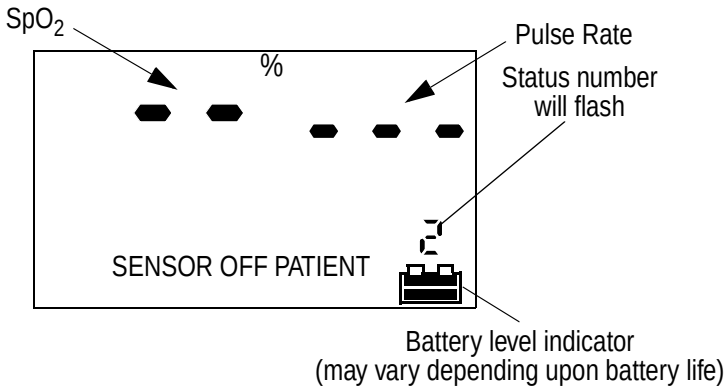

Figure 17. Sensor off patient display

4. Apply the sensor, check for a Pulse Bar to the left of the display. Verify that Saturation and Pulse rate values appear.
   If using the finger sensor apply to index finger.
   If using Y-Sensor apply using tape.

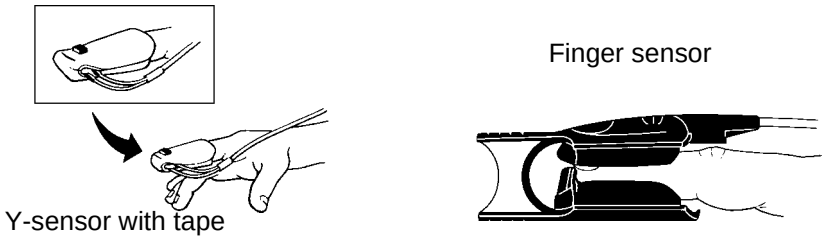

Figure 18. Applying sensor for functional test

5. Remove the sensor, verify the display blanks (Pulse and Saturation values are replaced by "-"). Check that SENSOR OFF PATIENT appears and the number 2 flashes.
   NOTE: REPOSITION SENSOR will appear if using the Y-sensor and the sensor heads are not facing eachother.

6. Verify an alert tone sounds, press the △ key and check that the alert tone is silenced and the audible alert disabled triangle appears on the display.

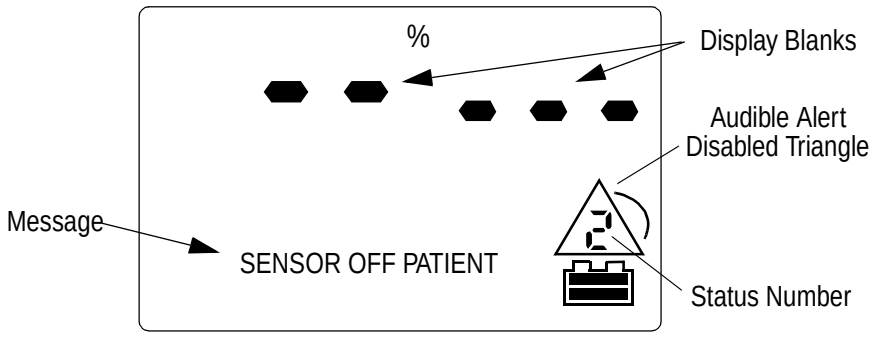

Figure 19. Sensor off patient display

7. Reapply the sensor, verify that the SpO_2 and pulse rate displays return along with the pulse bar.
8. Press the Audible Alert Disable key, verify that the audible alert triangle disappears. The current SpO_2 limits will appear for three seconds. The high limit will appear in the SATURATION display, the low limit in the PULSE RATE display. Verify the alert message and status number disappear.
   NOTE: The Saturation value must be within the limits in order to cancel all the alerts.
9. Turn the monitor off by pressing the ⏻ key. This completes the Functional Tests for the Model 511 and sensor. If the monitor and sensor performed as described above they are functionally operational.

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11 Accuracy Test

Introduction 11.1

The Accuracy Test verifies the performance accuracy of the Model 511 Pulse Oximeter monitor. This test is typically performed in conjunction with (after) the tests described in Section 10, *Functional Test*, on page 35. If the monitor does not pass the accuracy test, the monitor should be recalibrated. Refer to Section 12, *Electronic Test*, on page 43, or contact the Novametrix Service Department for repair/replacement assistance.

The test requires the use of the Model TB500B Sensor Simulator.[1] This is the same device used by the factory technicians to calibrate the monitor prior to shipping. The TB500B is an updated version of the TB500A Test Box. Owners of TB500A should contact the Novametrix Service Department for details on upgrading to the TB500B. Note that the TB500A, used in conjunction with the Cat. No. 5453-00 Adapter Cable[2], may be substituted for the TB500B in most parts of this test.

Monitor Accuracy Test 11.2

1. Equipment Required:
   Model 511 to be tested
   Model TB500B Sensor Simulator (Cat. No. 5330-00)
   Sensor Adapter Cable (Cat. No. 5977-00)
   Finger Sensor (Cat No 8744) or Y-Sensor (Cat No 8793)
2. Ensure that the batteries have sufficient charge to power the monitor. The combined voltage under load should be between 4-6 volts DC.

1. Available through the Novametrix Service Department.
2. The 5453-00 adapter cable must be used in conjunction with the 5977-00 adapter cable if using the TB500A.

3. Turn the Model 511 on by pressing the ⏻ key. Verify proper display power up sequence. See *Power On/Off* on page 7.

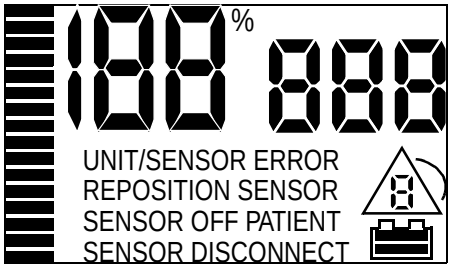

Figure 20. LCD display with all segments on

4. Connect the TB500B Sensor Simulator to the Model 511 sensor input cable using the 5977-00 adapter cable. Set the sensor simulator ATTENUATION to 1. Verify SENSOR OFF PATIENT and 2 appears on the display.
5. Verify the Saturation values listed in the table below;

Simulator Settings		TB500B	TB500A w/Adapt.
Sat. Setting	Atten.	Sat. Value	Cable Sat. Value
100	3	98-100	98-100
92	3	90-94	90-94
82	3	80-84	82-86
72	3	70-74	75-79
62	3	60-64	67-71
72	7	68-76	73-81
82	7	78-86	80-88
92	7	88-96	88-96
100	7	98-100	98-100

Table 7. Saturation values using sensor simulator

6. Verify the Pulse Rate is 60 bpm ± 1.
7. Set SATURATION to 0. Verify REPOSITION SENSOR and 3 appears on the display.
8. Press and hold the **RED** button on the TB500B. Check for UNIT/SENSOR ERROR and 7.
9. Disconnect the test box to reset the error. Verify display shows SENSOR DISCONNECT and 1. Reconnect the test box.
10. Press and hold the **INFRARED** button, verify UNIT/SENSOR ERROR and 7.
11. Disconnect the test box to reset the error. Verify display shows SENSOR DISCONNECT and 1. Reconnect the test box.

12. Turn the TB500B off, check that the display shows REPOSITION SENSOR and 4.
13. Disconnect the Sensor Simulator (the simulator should still be off).
14. Connect the sensor, verify SENSOR OFF PATIENT and the number 2 flashes. With the Y-Sensor, position the sensor heads so that they face each other (the red light shines at the detector).

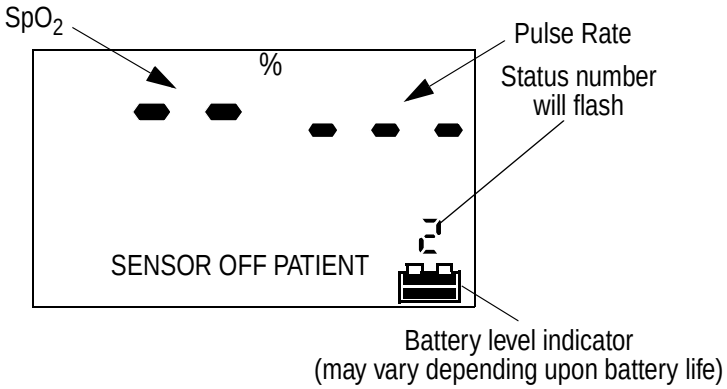

Figure 21. Alert display

15. Apply the sensor, check for a Pulse Bar to the left of the display. Verify that Saturation and Pulse rate values appear.
    If using the finger sensor apply to index finger.
    If using Y-Sensor apply using tape.

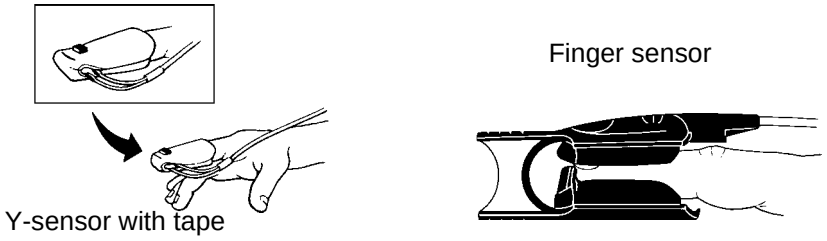

Figure 22. Application of Y-sensor and Finger sensor

16. Remove the sensor, verify the display blanks (Pulse and Saturation values are replaced by "-"). Check that SENSOR OFF PATIENT appears and the number 2 flashes.
    NOTE: REPOSITION SENSOR may appear if using the Y-sensor and the sensor heads are not facing eachother.
17. Turn the Model 511 off by pressing the ⏻ key. This completes the Accuracy Tests for the Model 511.

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12 Electronic Test

Introduction 12.1

The Electronic Test verify the operation of the electronic circuits within the Model 511. These *DO NOT* need to be performed on a regular basis. Perform these test only if the monitor fails to operate as expected and/or fails the *Functional Test* on page 35. These test should be performed only by qualified service personnel. Follow proper grounding procedures when handling the internal components to avoid damage from static discharge.

If the monitor does not pass the Electronic Tests, remove it from use and contact the Novametrix Service Department for repair/replacement assistance.

This procedure assumes the technician performs each step as indicated - leaving the monitor in a known state prior to performing the next step. If steps are omitted or performed out of order, be sure that the monitor is set to the correct state before continuing.

Monitor Functional Test 12.2

12.2.1 Equipment Required:
Model 511 to be tested
Finger Sensor (Cat. No. 8744) or Y-Sensor™ (Cat. No. 8793)
Model TB500B Sensor Simulator (Cat. No. 5330-00)[1]
Sensor Adapter Cable (Cat. No. 5977-00)
External DC power supply
Digital Voltage Multimeter
Small clip-leads
2.5 mm I.D. X 5.5 mm O.D. X 12 mm (barrel length) DC plug, or optional external DC supply

12.2.2 Disconnect the external DC supply if installed, remove the batteries, then disassemble the monitor to access the internal circuit boards. Carefully separate the boards from each other. See *Assembly Exchanges* on page 28.

1. The TB500A used in conjunction with the 5453-00 Adapter Cable can be substituted for the TB500B in most parts of this test. Owners of the TB500A should contact the Novametrix Service Department for details on upgrading to the TB500B.

2710 Analog Board 12.2.3

12.2.4 Connect VBATT to 5.0 VDC ± 0.1V at J404 using an external power supply.

12.2.5 Clip VBATT to the positive terminal of C24 on the 2710 Analog board, this will power the board up (momentarily connecting VBATT to this point will power up the board).

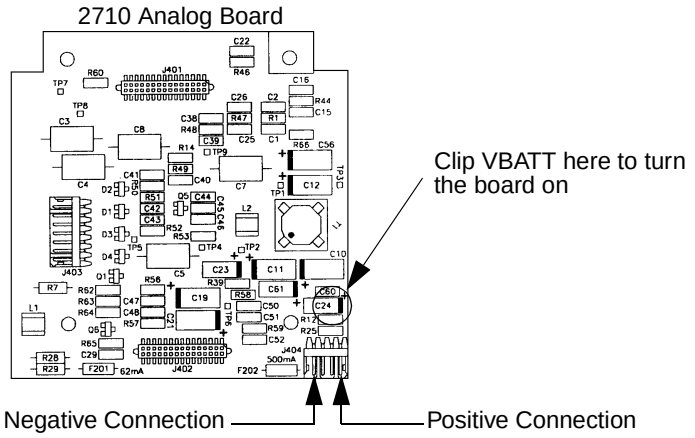

Figure 23. Cutaway showing location of C24 on the 2710 analog board

12.2.6 Measure and verify the following voltages.

Signal	Voltage	Test Point
VDCIN	5.0 ± 0.2 VDC	C11 positive term.
LEDPWR	6.3 ± 0.2 VDC	C20 positive term.
VDD	5.0 ± 0.2 VDC	C12 positive term.
+VA	5.0 ± 0.2 VDC	C19 positive term.
-VA	-5.0 ± 0.3 VDC	C21 negative term.
LEDSRC	5.2 ± 0.3 VDC	C36 positive term.
VREF	-2.50 ± 0.05 VDC	TP6
LEDPWR @ VBATT=3.3-3.7 VDC	6.3 ± 0.2 VDC	C20 positive term.
LEDPWR @ VBATT=5.8-6.2 VDC	6.3 ± 0.2 VDC	C20 positive term.

Table 8. 2710 analog board voltage checks

2711 Digital Board 12.2.7

12.2.8 Set an external DC supply to +5.00 ± 0.05 VDC, turn the supply off before connecting the digital board.

12.2.9 Connect the external DC power supply ground to IC3 ground. Connect the external DC power supply positive to IC3 VDD.

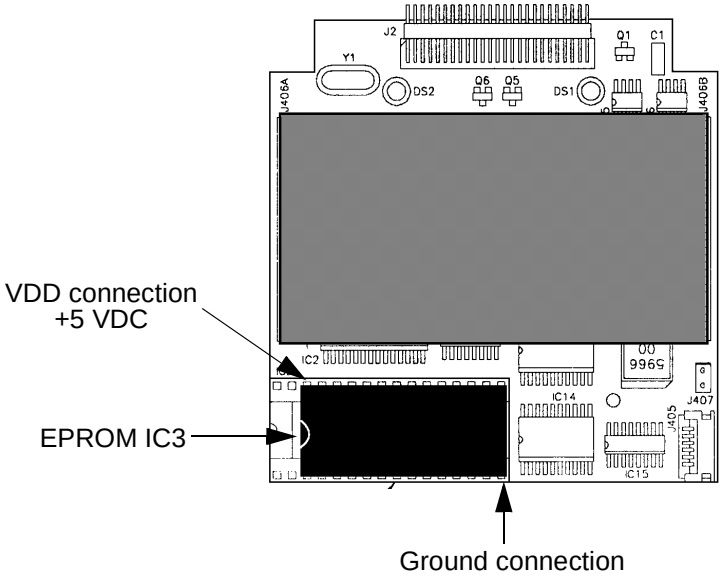

Figure 24. Connecting external DC supply to the 2711 Digital Board

12.2.10 Turn supply on, verify 5.0 VDC ± 0.1v

12.2.11 Verify proper display power up sequence.
NOTE: once the power up sequence is finished an error message will appear, this is due to the fact that the 2710 Analog Board is not connected.

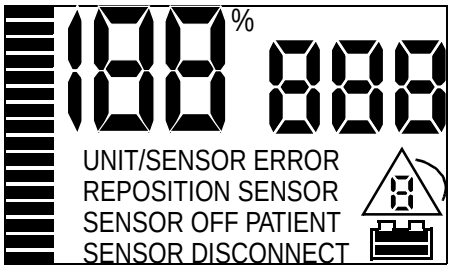

Figure 25. 2711 Digital board power up display

12.2.12 Measure the clock frequency on J2 pin 46 (or TP4 if available), verify 3.072 MHz ± 3KHz.

System Check 12.2.13

12.2.14 Connect the power connector (from battery compartment and DC input jack) to J404 on the 2710 Analog Board (the 2711 board should be removed for this).

12.2.15 Connect the Sensor cable's connector to J403 on the 2710 Analog board (without sensor attached).

12.2.16 Attach the 2710 and 2711 boards together, be sure to orient the boards together properly. If improperly attached and power is applied damage may occur.

12.2.17 Connect the membrane from the top cover to J405 on the 2711 Digital board.

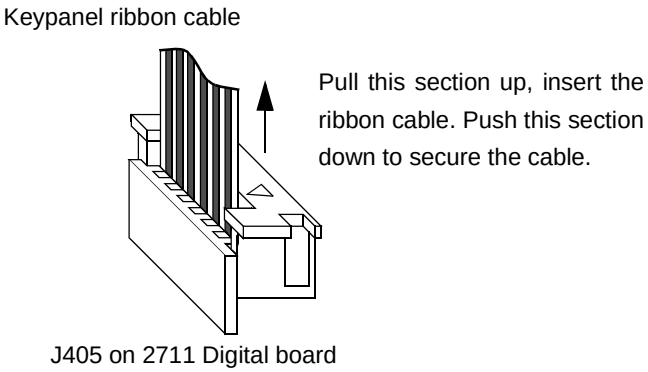
Keypanel ribbon cable
Pull this section up, insert the ribbon cable. Push this section down to secure the cable.
J405 on 2711 Digital board

Figure 26. Connecting membrane keypanel

12.2.18 Check that pins 2 and 3 on the DC input jack are open when a plug is inserted (use a dummy jack 2.5 mm I.D. X 5.5 mm O.D. X 12 mm Barrel length, or un-powered supply). This ensures that the batteries are disconnected when the external DC supply is connected. Remove the plug and check that pins 2 and 3 are shorted.

12.2.19 Batteries must not be installed! Connect an external supply set to 5.0 VDC ± 0.1V. Observe proper polarity, hookup the positive lead to the red wire battery connection, the negative lead to the black wire battery connection. (Ensure the dummy plug or external supply is not connected at this point).

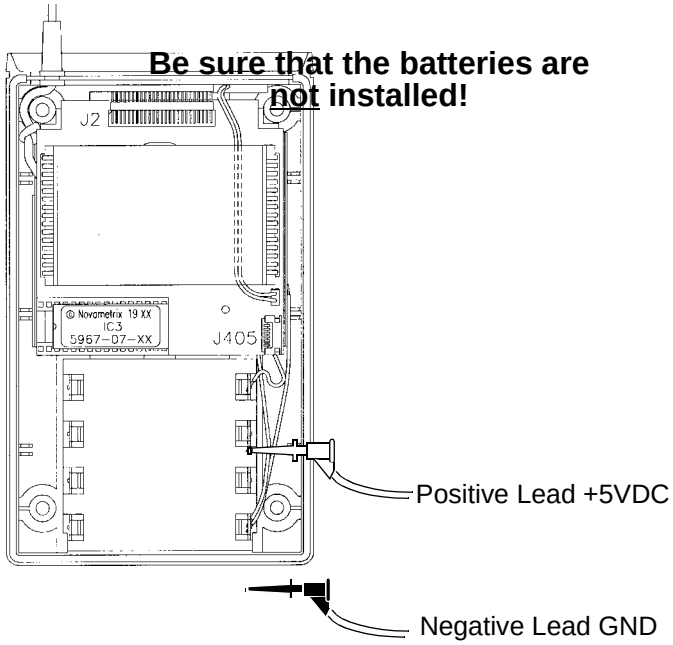

Figure 27. Connecting external DC supply

12.2.20 Turn the external supply on. Turn the model 511 on by pressing and holding the ⏻ key until the backlight illuminates.

12.2.21 Verify proper display power up sequence. See *Power On/Off* on page 7.

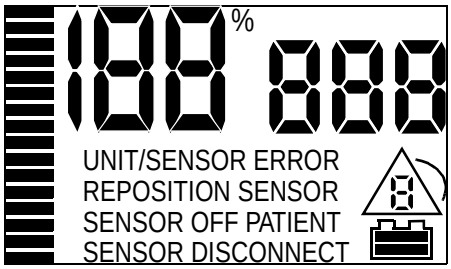

Figure 28. Display at power up with all segments active

12.2.22 Turn the monitor off by pressing the ⏻ key, press the ⏻ key again, verify the monitor powers up without the backlight illuminated.

12.2.23 Attach the sensor simulator to the Sensor cable using the 5977-00 adapter cable. Turn the simulator on. Set the ATTENUATION to 3 and the SATURATION to 100. Verify pulse bar, SpO_2 and Pulse rate values.

12.2.24 Set the sensor simulator ATTENUATION to 1. Verify SENSOR OFF PATIENT appears and a 2 blinks on the display. Check that the SATURATION and PULSE RATE displays blank out with "-".

12.2.25 Check that the monitor sounds an alert, press the △ key and verify that the audio is silenced and the audible alert triangle appears on the display.

12.2.26 Press the △ key again, verify the alert tone, and the audible alert triangle disappears. Check that the default alert limits appear: the high limit (100) in the SATURATION display, the low limit (85) in the PULSE RATE display.[2]

2. The default alert limits are set every time the monitor is turned on, if the △ key is pressed and held, the monitor will beep twice to indicate that the limits have been changed. If there is not valid SpO2 data in which to set new limits the monitor will retain the default limits and beep three times.

12.2.27 Verify the Saturation values listed in the table below (press the △ key to disable audible alarms if desired);

Sat. Setting	Atten.	TB500B Sat. Value	TB500A w/Adapt. Cable Sat. Value
100	3	98-100	98-100
92	3	90-94	90-94
82	3	80-84	82-86
72	3	70-74	75-79
62	3	60-64	67-71
72	7	68-76	73-81
82	7	78-86	80-88
92	7	88-96	88-96
100	7	98-100	98-100

12.2.28 Verify the Pulse Rate is 60 bpm ± 1.

12.2.29 Set the SATURATION to 82, ATTENUATION to 3, check for the SpO_2 display to settle between 80-84.

12.2.30 Press and hold the △ key. Verify new alert limits appear in the SpO_2 and Pulse Rate displays, the monitor will also beep twice.

12.2.31 Set the SATURATION to 100, verify H blinks on the display (audible alarm will sound if not enabled).

12.2.32 Set the SATURATION to 62, verify L blinks on the display (audible alarm will sound if enabled).

12.2.33 Set the SATURATION to 82, verify alerts clear.

12.2.34 Set SATURATION to 0. Verify REPOSITION SENSOR appears and a 3 blinks on the display.

12.2.35 Press and hold the **RED** button on the TB500B. Check for UNIT/SENSOR ERROR and 7.

12.2.36 Disconnect the test box to reset the error. Verify display shows SENSOR DISCONNECT and 1. Reconnect the simulator.

12.2.37 Press and hold the **INFRARED** button, verify UNIT/SENSOR ERROR and 7.

12.2.38 Disconnect the test box to reset the error. Verify display shows SENSOR DISCONNECT and 1. Reconnect the simulator.

12.2.39 Turn the TB500B off, check that the display shows REPOSITION SENSOR and 4.

12.2.40 Turn the Model 511 of by pressing the ⏻ key. This completes the Electronic Tests of the Model 511, re-assemble the monitor. See *Assembly Exchanges* on page 28.

13 Specifications

General 13.1

Specifications for the Novametrix Model 511 Pulse Oximeter, are listed for informational purposes only, and are subject to change without notice.

Oxygen Saturation (SpO_2) 13.1.1

- Range, 0-100%
- Accuracy, 80-100% ± 2%, 0-79% unspecified
  (Approximately 68% of the observations are within the accuracy claim.)
- Display Resolution, 1 SpO_2 digit
- Averaging Time, fixed at 8 seconds
- Settling Time
  Display settles to within 1% of the final reading less than 15 seconds after the sensor is properly applied.

Pulse Rate 13.1.2

- Range, 30-250 beats per minute (bpm)
- Accuracy, ± 1% of full scale
  (Approximately 68% of the observations are within the accuracy claim.)
- Display Resolution, 1 bpm
- Averaging Time, fixed at 8 seconds
- Settling Time
  Display settles to within 1% of the final reading less than 15 seconds after the sensor is properly applied.

General Specifications 13.1.3

- Operating Environment
  50-104 °F (10-40 °C), 0-90% relative humidity (non-condensing)
- Weight, 13 ounces including batteries (without printer)
- Dimensions
  Height 6.25 inches, Width 3.75 inches, Depth 1.3 inches
- Battery
  Type, four “AA” alkaline cells. Life, 12 hours.
- Optional External Power Supply
  Input: 105-130 VAC, 50/60Hz* or 230 VAC, 50/60Hz**
  Output: 6 VDC @ 150ma
  Cord Length: 6 ft
  *105-130 volt unit designed to meet electrical tests of U. L. 544 Patient Care Equipment-Patient Connected/Isolated
  **230 volt unit designed to IEC601 Electrical Specification

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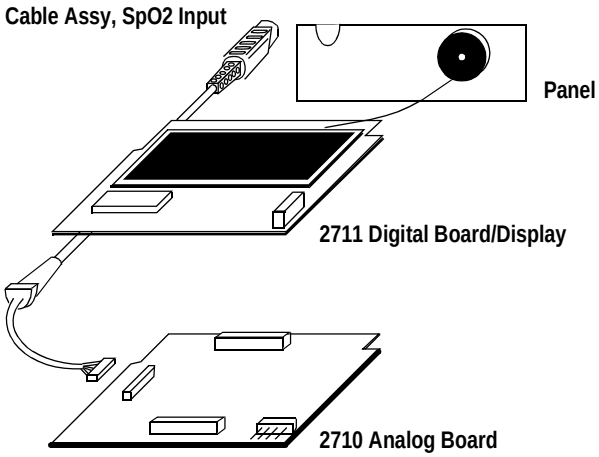
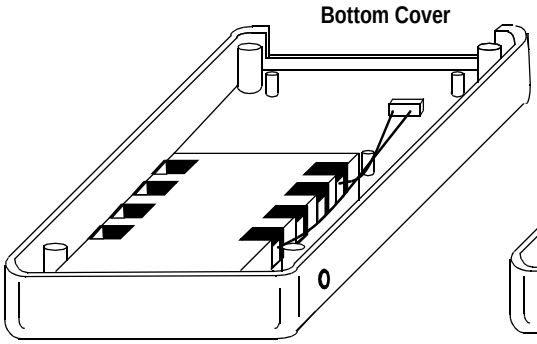
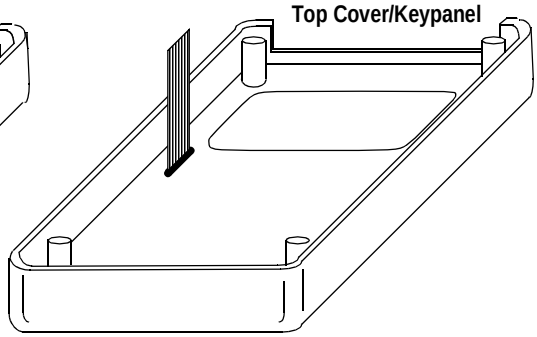
14 Parts Lists

Model 511 Assemblies 14.1

The different assemblies and parts that make up the Model 511 are shown below. Assemblies with parts list (part numbers with description) follow. There may be slight differences in assemblies (speaker placement for example).







ASSY: 6116-00 00 PULSE OXIMETER - MODEL 511

LINE	PART NO	REV	QPA	DESCRIPTION
0001	6116-01	00	1	MAIN ASSY, MODEL 511
0002	6116-09	00	0	OVERALL WIRING DIAGRAM, MODEL 511
0003	6116-23	XX	1	USERS MANUAL, MODEL 511
0004	6116-90	XX	1	SERVICE MANUAL, MODEL 511
0005	6070-32	00	1	LABEL, SERIAL NUMBER
0006	400038		4	BATTERY, 1.5V DC, AA SIZE

ASSY: 6116-01 00 MAIN ASSY, MODEL 511

LINE	PART NO	REV	QPA	DESCRIPTION
0001	6102-10	00	2	SUPPORT, PCB, MODEL 510 - SPOT CHECK
0002	6116-04	XX	0	TEST PROCEDURE, MODEL 511
0003	6109-01	00	1	TOP COVER ASSY, MODEL 511
0004	6080-01	00	1	BOTTOM COVER ASSY, MODEL 511
0005	6108-01	00	1	SPO2 MODULE ASSY, MODEL 511
0006	161007		0	SUPERBONDER 414 ADHESIVE
0006	161069		0	ADHESIVE, 401, FAST-SETTING, MEDIUM VISCOSITY

ASSY: 6109-01 00 TOP COVER ASSY, MODEL 511

LINE	PART NO	REV	QPA	DESCRIPTION
0001	5923-11	01	1	TOP COVER MODIFICATION
0002	6078-10	00	1	REFLECTOR
0003	6092-27	00	1	MEMBRANE KEYPANEL
0004	161007		0	SUPERBONDER 414 ADHESIVE
0005	161089		0	TAPE, FOAM, .25W X .062T, BLK, PRESS SENS

ASSY: 6080-01 00 BOTTOM COVER ASSY, MODEL 511

LINE	PART NO	REV	QPA	DESCRIPTION
0002	6106-11	00	1	BOTTOM COVER MODIFICATION W 4 SCREWS
0004	6079-01	00	1	POWER CABLE ASSY, MODEL 511
0006	210141		1	CONNECTOR, DC PWR JACK, SOLDER TERM
0007	161060		0	EPOXY, 2 PART (5/7), GRAY
0008	161090		0	TAPE, FOAM, B-41 NEOPRENE, .5W X .125T, BLK,
0009	280201		4	ROLL PIN, 2.5MM DIA X 10MM LONG, STAINLESS ST
0010	280202		4	O-RING, 15/64 OD X 7/64 ID X .070 THK, SILICON
0011	5645-10	00	0	WIRE, 30AWG, DARK BLUE, CS95 ALLOY, FEP INSUL

ASSY: 6079-01 00 POWER CABLE ASSY, MODEL 511

LINE	PART NO	REV	QPA	DESCRIPTION
0001	211417		1	CONNECTOR, 4 PIN, RECEPTACLE, 28AWG THRU 26AW
0002	5639-10	00	0	WIRE, 28AWG, BLACK, CS95 ALLOY, FEP INSULATION
0003	5641-10	00	0	WIRE, 28AWG, RED, CS95 ALLOY, FEP INSULATION
0004	5644-10	00	0	WIRE, 28AWG, GREEN, CS95 ALLOY, FEP INSULATION

ASSY: 6108-01 00 SPO2 MODULE ASSY, MODEL 511

LINE	PART NO	REV	QPA	DESCRIPTION
0001	2710-01	01	1	ANALOG BOARD ASSY
0002	2711-01	01	1	DIGITAL BOARD ASSY
0003	6107-07	XX	1	PROGRAM, EPROM ASSY, SPO2, MODEL 511
0004	6105-01	00	1	CABLE ASSY, SPO2 INPUT, HAND HELD
0005	161060		0	EPOXY, 2 PART (5/7), GRAY
0006	482578		1	LCD
0007	5911-10	00	1	PANEL, END, MODEL 511

ASSY: 2710-01 00 Analog Board Assy (see next listing for revision 01 boards)

LINE	PART NO	REV	QPA	DESCRIPTION
0001	2710-02	00	1	FAB, ANALOG BOARD
0002	2710-03	00	0	SCHEMATIC, ANALOG BOARD
0003	154062		2	CAPACITOR, .01UF, 50V, 10%, X7R, SURFACE MOUNT
0004	154072		36	CAPACITOR, .1UF, 50V, 10%, CERAMIC CHIP, SURF
0005	154079		3	CAPACITOR, 10UF, 16V, 10%, TANTALUM, SURFACE
0006	154080		13	CAPACITOR, 47UF, 10VDC, 10%, TANTALUM, SURFACE
0007	154084		1	CAPACITOR, 2700PF, 100V, 10%, X7R, MLTILYR CER.
0008	154085		2	CAPACITOR, 47PF, 100VDC, 5%, MLTILYR CER, SURF.
0009	154088		5	CAPACITOR, .1UF, 50VDC, METALZD POLYCARBONATE
0010	180019		1	INDUCTOR, 100UH, 10%, SURFACE MOUNT
0011	180021		1	INDUCTOR, 20UH PARALLEL/80UH SERIES, SURFACE
0012	180022		1	INDUCTOR, 10UH, 10%, SURFACE MOUNT
0013	211415		1	CONNECTOR, 4 PIN, HEADER, .079 SP, R ANG, PC
0014	211718		1	CONNECTOR, 7 PIN, HEADER, .079 SP, R ANG, PC
0015	213005		2	CONNECTOR, 30 PIN, PLUG, DIL, .05 SP
0016	472198		1	RESISTOR, 3.3 OHM, 1/4W, 1%, CARBON
0017	472200		1	RESISTOR, 5.6 OHM, 1/4W, 1%
0018	472274		1	RESISTOR, 26.7 OHM, 1/4W, 1%
0019	474138		9	RESISTOR, 100 OHM, 1/8W, 1%, SURFACE MOUNT
0020	474153		22	RESISTOR, 42.2K OHM, 1/8W, 1%, SURFACE MOUNT
0021	474157		3	RESISTOR, 511 OHM, 1/8W, 1%, SURFACE MOUNT
0022	474165		5	RESISTOR, 10K OHM, 1/8W, 1%, SURFACE MOUNT
0023	474166		8	RESISTOR, 100K OHM, 1/8W, 1%, SURFACE MOUNT
0024	474172		9	RESISTOR, 10 OHM, 1/8W, 1%, SURFACE MOUNT
0025	474175		5	RESISTOR, 3.92K OHM, 1/8W, 1%, SURFACE MOUNT
0026	481546		4	DIODE, MMBD914L, SWITCHING, SURFACE MOUNT
0027	481547		2	DIODE, MMBD301L, HOT CARRIER SCHOTTKY, SURF M

LINE	PART NO	REV	QPA	DESCRIPTION
0028	481549		1	DIODE, MBRS140T3, RECTIFIER, SURFACE MOUNT
0029	484061		2	TRANSISTOR, MMBT2222ALT1, NPN, SOT-23, SURF M
0030	484541		1	VOLTAGE REGULATOR, LM317LD, +1.2V - +37V OUT,
0031	484548		1	VOLTAGE CONVERTER, MAX752CWE, DC-DC, +5V @ 20
0032	484549		1	VOLTAGE CONVERTER, LT1044CS8, 5VDC, 8 PIN SURF
0033	484550		1	VOLTAGE REGULATOR, LT1121CS8-5, +5V, 150MA
0034	485532		4	TRANSISTOR, 2N7002, N-CHANNEL ENHAN MODE
0035	485537		3	TRANSISTOR, SI9942DY, MOSFET, N/P-CHANNEL
0036	486324		1	IC, DG444DY, QUAD SPST CMOS ANALOG SW
0037	486332		2	IC, AD7703BR, 20-BIT A TO D CONVERTER, SURFACE
0038	486334		1	IC, MC14051BD, 8-CH ANALOG MUX/DEMUX, 16 PIN
0039	486788		1	IC, LT1019CS8-2.5, PREC VOLTAGE REF, 2.5V
0040	486794		1	IC, PM7524FS, 8-BIT D TO A CONV, 16 PIN, SURF
0041	486795		1	IC, TLC549ID, 8-BIT A TO D CONV, SERIAL
0042	486796		1	IC, TLC2272CD, DUAL OP AMP, RAIL TO RAIL
0043	487084		3	IC, OP-282GS, DUAL JFET OP AMP, L PWR, H SPD
0044	515074		1	FUSE, 1/16A, 125V, VERY FAST-ACTING, SUBMIN
0045	515076		1	FUSE, 1/2A, 125V, VERY-FAST ACTING, SUBMIN

ASSY: 2710-01 01 ANALOG BOARD ASSY, MODEL 510 - SPOT CHECK

LINE	PART NO	REV	QPA	DESCRIPTION
0001	2710-02	01	1	FAB, ANALOG BOARD
0002	2710-03	01	0	SCHEMATIC, ANALOG BOARD
0003	154062		2	CAPACITOR, .01UF, 50V, 10%, X7R, SURFACE MOUNT
0004	154072		40	CAPACITOR, .1UF, 50V, 10%, CERAMIC CHIP, SURF
0005	154079		3	CAPACITOR, 10UF, 16V, 10%, TANTALUM, SURFACE
0006	154080		13	CAPACITOR, 47UF, 10VDC, 10%, TANTALUM, SURFACE
0007	154084		1	CAPACITOR, 2700PF, 100V, 10%, X7R, MLTILYR CER
0008	154085		2	CAPACITOR, 47PF, 100VDC, 5%, MLTILYR CER, SURF
0009	154088		3	CAPACITOR, .1UF, 50VDC, METALZD POLYCARBONATE
0010	180019		1	INDUCTOR, 100UH, 10%, SURFACE MOUNT
0011	180021		1	INDUCTOR, 20UH PARALLEL/80UH SERIES, SURFACE
0012	180022		1	INDUCTOR, 10UH, 10%, SURFACE MOUNT
0013	211415		1	CONNECTOR, 4 PIN, HEADER, .079 SP, R ANG, PC
0014	211718		1	CONNECTOR, 7 PIN, HEADER, .079 SP, R ANG, PC
0015	213005		2	CONNECTOR, 30 PIN, PLUG, DIL, .05 SP, STR, SU
0016	472198		1	RESISTOR, 3.3 OHM, 1/4W, 1%, CARBON
0017	472200		1	RESISTOR, 5.6 OHM, 1/4W, 1%
0018	472274		1	RESISTOR, 26.7 OHM, 1/4W, 1%
0019	474138		9	RESISTOR, 100 OHM, 1/8W, 1%, SURFACE MOUNT
0020	474153		19	RESISTOR, 42.2K OHM, 1/8W, 1%, SURFACE MOUNT
0021	474157		3	RESISTOR, 511 OHM, 1/8W, 1%, SURFACE MOUNT
0022	474165		6	RESISTOR, 10K OHM, 1/8W, 1%, SURFACE MOUNT
0023	474166		8	RESISTOR, 100K OHM, 1/8W, 1%, SURFACE MOUNT
0024	474172		9	RESISTOR, 10 OHM, 1/8W, 1%, SURFACE MOUNT
0025	474175		5	RESISTOR, 3.92K OHM, 1/8W, 1%, SURFACE MOUNT
0026	481546		4	DIODE, MMBD914L, SWITCHING, SURFACE MOUNT

LINE	PART NO	REV	QPA	DESCRIPTION
0027	481547		2	DIODE, MMBD301L, HOT CARRIER SCHOTTKY, SURF M
0028	481549		1	DIODE, MBRS140T3, RECTIFIER, SURFACE MOUNT
0029	484060		2	TRANSISTOR, MMBT3904T, NPN, SURFACE MOUNT
0030	484541		1	VOLTAGE REGULATOR, LM317LD, +1.2V - +37V OUT,
0031	484548		1	VOLTAGE CONVERTER, MAX752CWE, DC-DC
0032	484549		1	VOLTAGE CONVERTER, LT1044CS8, 5VDC, 8 PIN SUR
0033	484550		1	VOLTAGE REGULATOR, LT1121CS8-5, +5V, 150MA
0033	484551		0	VOLTAGE REGULATOR, MAX666CSA, +5VDC, 50MA
0034	485532		6	TRANSISTOR, 2N7002, N-CHANNEL ENHAN MODE
0035	485537		1	TRANSISTOR, SI9942DY, MOSFET, N/P-CHANNEL
0036	486324		1	IC, DG444DY, QUAD SPST CMOS ANALOG SW, SURF M
0037	486332		2	IC, AD7703BR, 20-BIT A TO D CONVERTER, SURFAC
0038	486334		1	IC, MC14051BD, 8-CH ANALOG MUX/DEMUX, 16 PIN
0039	486788		1	IC, LT1019CS8-2.5, PREC VOLTAGE REF, 2.5V
0040	486794		1	IC, PM7524FS, 8-BIT D TO A CONV, 16 PIN, SURF
0041	486795		1	IC, TLC549ID, 8-BIT A TO D CONV, SERIAL CONTR
0042	486796		1	IC, TLC2272CD, DUAL OP AMP, RAIL TO RAIL
0043	487084		3	IC, OP-282GS, DUAL JFET OP AMP, L PWR, H SPD
0044	515074		1	FUSE, 1/16A, 125V, VERY FAST-ACTING, SUBMIN
0045	515076		1	FUSE, 1/2A, 125V, VERY-FAST ACTING, SUBMIN
0046	485541		1	TRANSISTOR, SI9947DY, MOSFET, DUAL P-CH ENH

ASSY: 2711-01 00 Digital Board Assy (see next listing for revision 01 boards)

LINE	PART NO	REV	QPA	DESCRIPTION
0001	2711-02	00	1	FAB, DIGITAL BOARD
0002	2711-03	00	0	SCHEMATIC, DIGITAL BOARD
0003	5965-07	XX	1	PROGRAM, PEEL ASSY, CSIO CONTROLLER
0004	5966-07	XX	1	PROGRAM, PEEL ASSY, TIMING SEQUENCER
0005	130011		1	ALARM, 4KHZ, .66 DIA X .16 HIGH, W 4 IN. L LE
0006	154072		16	CAPACITOR, .1UF, 50V, 10%, CERAMIC CHIP, SURF
0007	154079		3	CAPACITOR, 10UF, 16V, 10%, TANTALUM, SURFACE
0008	154082		3	CAPACITOR, 22PF, 100V, 10%, NPO, MLTILYR CERAMIC
0009	180011		1	FERRITE BEAD, 22 AWG TCW WIRE THRU CORE
0010	211631		1	CONNECTOR, 6 PIN, FLEX CABLE VERT ENTRY, PC MNT
0011	213004		2	CONN, 30 PIN, RCPTLE, DIL, .05 SP, STR, SURF
0012	213509		1	CONNECTOR, 50 PIN, HEADER, DIL, .050 SP, R ANGLE
0013	215059		1	SOCKET, 32 PIN, LOW PROFILE, .6 SPACING
0014	215072		2	SOCKET STRIP, 15 PIN, SIL, .100 SPACING, PC MNT
0015	230023		1	CRYSTAL, 12.288 MHZ, HC49S CASE
0016	280207		0	SPACER, 3/16 DIA X 1/8 LONG, .09 DIA CLRNCE,
0017	474137		1	RESISTOR, 1M OHM, 1/8W, 1%, SURFACE MOUNT
0018	474138		3	RESISTOR, 100 OHM, 1/8W, 1%, SURFACE MOUNT
0019	474165		9	RESISTOR, 10K OHM, 1/8W, 1%, SURFACE MOUNT
0020	474166		18	RESISTOR, 100K OHM, 1/8W, 1%, SURFACE MOUNT
0021	481546		5	DIODE, MMBD914L, SWITCHING, SURFACE MOUNT
0022	482581		2	LAMP, CLEAR, PC MOUNT
0023	485532		6	TRANSISTOR, 2N7002, N-CHANNEL ENHAN MODE, SUR

LINE	PART NO	REV	QPA	DESCRIPTION
0024	486031		1	IC, MAX7231CFIQH, TRIPLXD LCD DECODER/DRIVER
0025	486306		1	IC, MCM60L256AF10, 32K X 8 CMOS SRAM, 100NS
0026	486319		1	IC, MC14020BD, 14-BIT BINARY COUNTER, SURF MNT
0027	486320		1	IC, SN74HC14D, HEX SCHMITT-TRIGGER INV, SURF
0028	486321		1	IC, SN74HC138D, 3-LINE TO 8-LINE DECDR, SURF
0029	486323		2	IC, SN74HC573DW, OCTAL D-TYPE LATCH
0030	486329		2	IC, SN74HC32D, QUAD 2-IN. POS OR GATE, SURF MNT
0031	486333		1	IC, HD64180RCP-6X, 8-BIT MPU, HI INT, 68 PIN
0032	487085		1	IC, MAX872CSA, 2.5V PREC VOLTAGE REF, SURFACE
0033	487086		1	IC, MAX690ACSA, MICPRCS SUPERVISORY CKT, 8 PIN

ASSY: 2711-01 01 DIGITAL BOARD ASSY, MODEL 510 - SPOT CHECK

LINE	PART NO	REV	QPA	DESCRIPTION
0001	2711-02	01	1	FAB, DIGITAL BOARD
0002	2711-03	01	0	SCHEMATIC, DIGITAL BOARD
0003	5965-07	XX	1	PROGRAM, PEEL ASSY, CSIO CONTROLLER
0004	5966-07	XX	1	PROGRAM, PEEL ASSY, TIMING SEQUENCER
0005	130011		1	ALARM, 4KHZ, .66 DIA X .16 HIGH, W 4 IN. L
0006	154072		14	CAPACITOR, .1UF, 50V, 10%, CERAMIC CHIP, SURF
0008	154082		3	CAPACITOR, 22PF, 100V, 10%, NPO, MLTILYR CER
0009	180011		1	FERRITE BEAD, 22 AWG TCW WIRE THRU CORE
0010	211631		1	CONNECTOR, 6 PIN, FLEX CABLE VERT ENTRY
0011	213004		2	CONN, 30 PIN, RCPTLE, DIL, .05 SP, STR, SURF
0012	213509		1	CONNECTOR, 50 PIN, HEADER, DIL, .050 SP, R ANGLE
0013	215059		1	SOCKET, 32 PIN, LOW PROFILE, .6 SPACING
0014	215072		2	SOCKET STRIP, 15 PIN, SIL, .100 SPACING, PC MNT
0015	230023		1	CRYSTAL, 12.288 MHZ, HC49S CASE
0016	280207		0	SPACER, 3/16 DIA X 1/8 LONG, .09 DIA CLRNCE,
0018	474138		2	RESISTOR, 100 OHM, 1/8W, 1%, SURFACE MOUNT
0019	474165		9	RESISTOR, 10K OHM, 1/8W, 1%, SURFACE MOUNT
0020	474166		18	RESISTOR, 100K OHM, 1/8W, 1%, SURFACE MOUNT
0021	481546		5	DIODE, MMBD914L, SWITCHING, SURFACE MOUNT
0022	482581		2	LAMP, CLEAR, PC MOUNT
0023	485532		5	TRANSISTOR, 2N7002, N-CHANNEL ENHAN MODE, SUR
0024	486031		1	IC, MAX7231CFIQH, TRIPLXD LCD DECODER/DRIVER
0025	486306		1	IC, MCM60L256AF10, 32K X 8 CMOS SRAM, 100NS
0026	486319		1	IC, MC14020BD, 14-BIT BINARY COUNTER, SURF MNT
0027	486320		1	IC, SN74HC14D, HEX SCHMITT-TRIGGER INV, SURF
0028	486321		1	IC, SN74HC138D, 3-LINE TO 8-LINE DECDR, SURF
0029	486323		2	IC, SN74HC573DW, OCTAL D-TYPE LATCH
0030	486329		2	IC, SN74HC32D, QUAD 2-IN. POS OR GATE, SURF MNT
0031	486333		1	IC, HD64180RCP-6X, 8-BIT MPU, HI INT, 68 PIN
0034	487098		1	IC, MAX705CSA, UPROCESSOR SPRVISORY CKT

ASSY: 6105-01 00 CABLE ASSY, SPO2 INPUT

LINE	PART NO	REV	QPA	DESCRIPTION
0001	5906-16	00	1	STRAIN RELIEF, SPO2 INPUT CABLE
0002	5707-01	00	1	CABLE SUB-ASSY, 8 FOOT EXTENSION WITH OXYSNAP
0003	211719		1	CONNECTOR, 7 PIN, RECEPTACLE, 28AWG THRU 26AW
0004	605303		0	#30 AWG. TEFLON WIRE, ORANGE
0005	608003		0	TUBING, HEAT SHRINK, 1/8 (3.2) DIA, BLACK
0006	608005		0	TUBING, HEAT SHRINK, 1/16 (1.6) DIA, BLACK

ASSY: 5707-01 00 CABLE SUB-ASSY, 8 FOOT EXTENSION WITH OXYSNAP

LINE	PART NO	REV	QPA	DESCRIPTION
0001	8884-10	01	8	CABLE, 30AWG, 3 SINGLE & 1 TW SHLD PR, POLYUR
0002	9618-22	01	0	DESIGN SPECIFICATION, OXYSNAP CONNECTOR SYS.

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15 Schematic and Assembly Drawings

Drawing	Description
6116-09	Overall Wiring Diagram
2710-01	Analog Board, Assy
2710-03	Analog Board, Schematic
2711-01	Digital Board, Assy
2711-03	Digital Board, Schematic

Table 9. Schematic and Assembly Drawings

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